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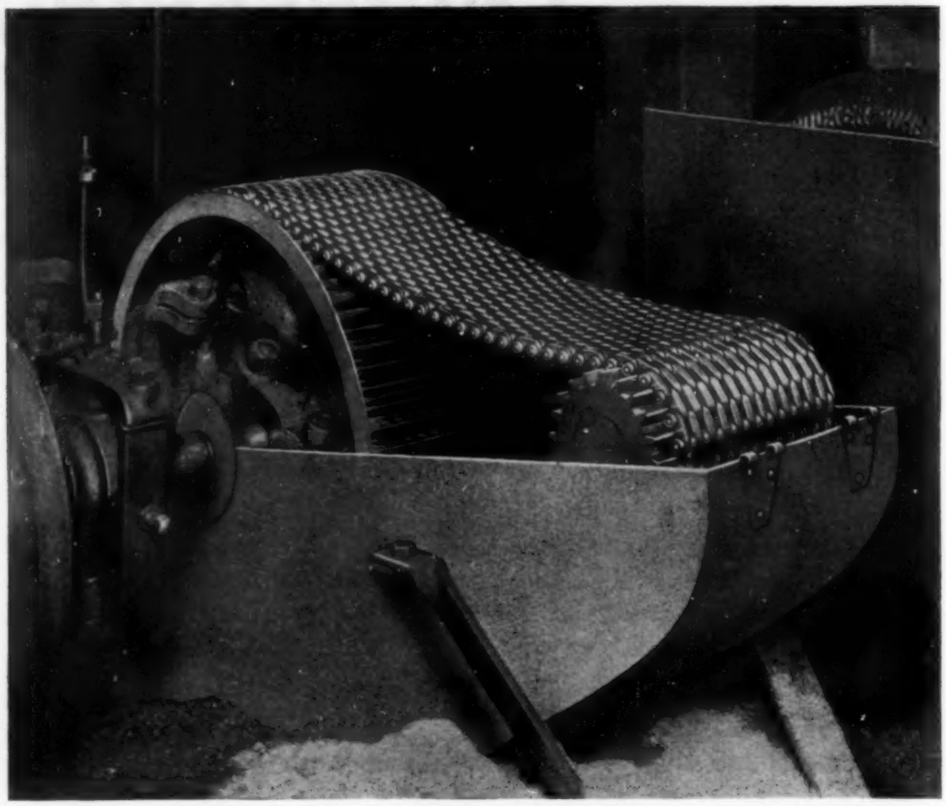

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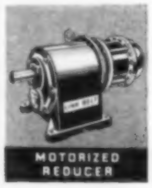

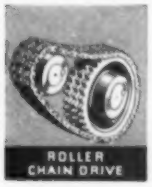

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S. D. KIRKPATRICK, Editor

MARCH, 1936

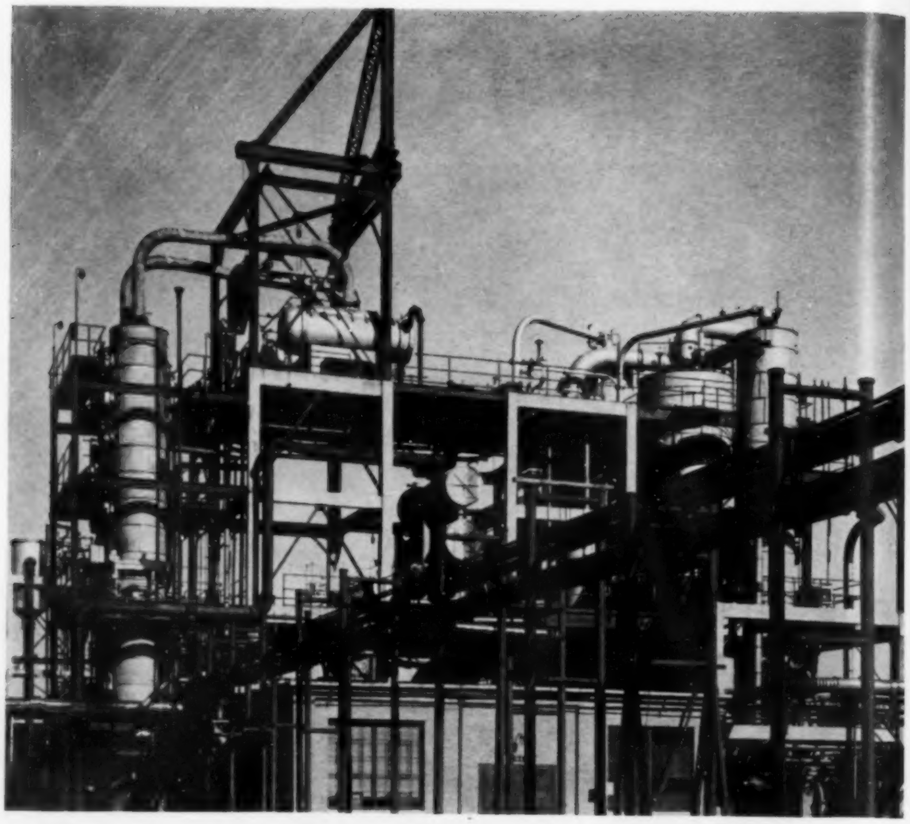
PERSONNEL PROBLEMS TO THE FORE

IS THE SITUATION reported by the chairman of the Employment Bureau of the Chemists' Club in New York typical of conditions in the entire chemical profession? Eighteen months ago, according to J. M. Weiss, there were 3,000 names on the club's list. Today there are only about 500, half of whom are still employed, but merely seeking to better their present positions. There is a brisk demand for, in fact, an actual shortage of, younger, highly trained men, needed especially for research and teaching. Heads of chemical engineering in two or three universities report having already placed all of the first-class men from among their prospective graduates of next June.

Such happy augury of business revival would be most encouraging were it not for the fact that this situation has also brought with it some serious problems for the profession. One of the most acute is the greater difficulty in placing older men. Mr. Weiss notes 65 chemists or engineers on his list who are over 40, but mostly under 50, and who cannot find re-employment at present, because many chemical companies have set arbitrary age-limits for new employees. This attitude has resulted, to some extent at least, from fear and uncertainty regarding state and federal legislation for old-age pensions and so-called social security. In the end it is likely to prove extremely short-sighted. It places a penalty on experience, judgment and the valuable attributes of maturity. It leads to further lack of balance in technical personnel that will inevitably be reflected in higher turnover and slower progress.

Companies now recruiting their technical staffs entirely from the ranks of recent graduates are also putting a heavy burden on their present personnel. In many instances these companies might better take on one or two older men of experience who could help share in the problems of supervision and management. As business improves managerial problems become more acute and there is less time to spend in training new men to fill positions of increasing responsibility.

Modernization of man-power is today management's most important problem. With it comes the obligation to face all the facts, squarely and honestly. If new personnel is needed, the best men available for the work should be hired, regardless of arbitrary age limits. If promotions and salary increases for present employees have been unduly delayed, now is the time to build and strengthen the organization from within. With a little encouragement of this sort on the part of a few of the more progressive chemical companies, the unemployment problems of the chemical profession bid fair to be solved, promptly and equitably.



FROM AN EDITORIAL VIEWPOINT

Must Taxes Be Punitive?

TAXES, most of us feel, are inevitable and perhaps the sooner a sane measure can be enacted, the better off we will be as a nation. Nothing emphasizes the need for economy quite so much as having to pay dearly for unwise expenditure. Business is willing to carry its share of the burden if the tax is equitably distributed and honestly enforced. But if a tax bill is to become a political instrument for a demogogic Congress to "soak the rich" or is to be used by the administration as a drastic means of punishing business enterprise through revolutionary measures of reform, then it is certainly time that saner counsel should prevail. Somewhere, presumably in the Treasury Department, there are actuarial experts who can help lay out a logical program that will yield the necessary revenue without undermining the very foundations on which business recovery must be built. Perhaps it is too much to expect in a year of presidential election that a non-political bill be enacted. But in the long run, it is good politics to handle government business on a straightforward honest basis. More revenue, rather than reform, is needed.

T.V.A. Must Proceed With Caution

WHEN the first flush of victory had passed and the directors of the Tennessee Valley Authority had settled down to a more sober consideration of that Supreme Court decision of February 17, 1936, they must have been mighty thankful that they had not rushed headlong into the commercial fertilizer business. To be sure, a sizeable program of factory scale production was under way, but fortunately for T.V.A., all of the product had been used for experimental work rather than sold directly in competition with private industry. Furthermore, the product was used for the most part, in demonstration work that some day might conceivably lead to an expansion of the market for the fertilizer manufacturer. So far—so good. The experimental work should continue as long as it is

truly experimental in advancing either the arts of fertilizer production or utilization. The Supreme Court decision without in any way mentioning the fertilizer program, nevertheless sounded a very definite note of warning, perhaps to this effect: Proceed with caution, experiment, demonstrate, but do not utilize "means of carrying on competitive commercial enterprise."

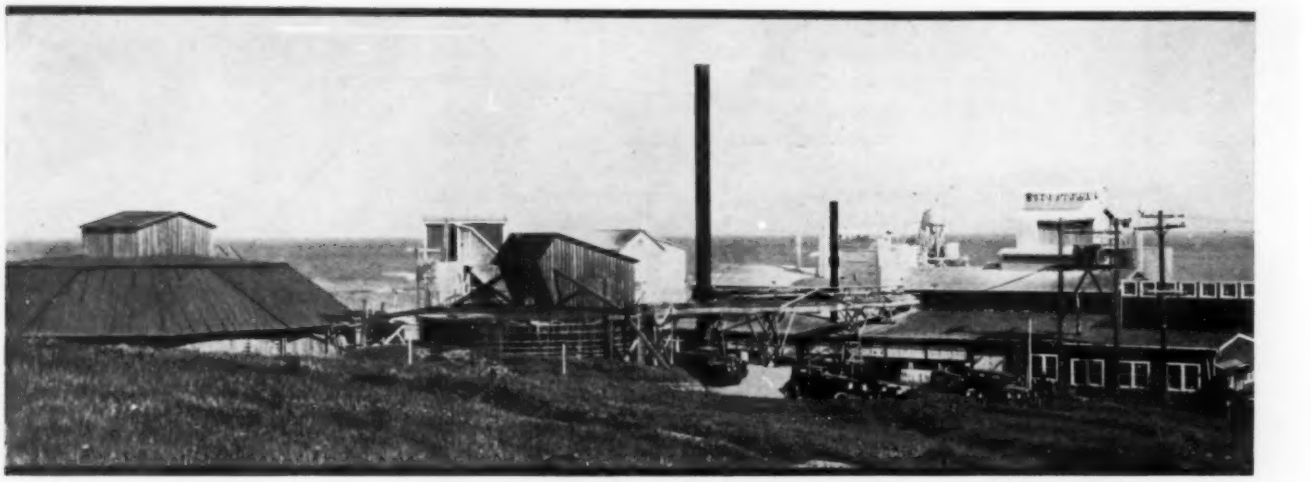
»Revealing a 20-year Old Secret

OLDSTERS among the rubber technologists will recall a mythical figure of twenty years ago whose trenchant writings in *Chem. & Met.* under the *nom de plume,* "Andrew H. King," did much to stir that industry out of an almost fatal lethargy. For nearly six years these articles and signed editorials kept driving at the need for a freer exchange of scientific and technical information in an industry hamstrung with secret fetishes and narrowly interested only within its own limited field. Gradually that wall of secrecy was penetrated and the technology of the industry rapidly advanced as its scientific outlook broadened. Impartial observers have publicly stated that much of the credit for this awakening was due to the writings of the mythical "Andrew H. King."

With the accidental and extremely unfortunate death in Nitro, W. Va., last month, of C. Olin North, was written the concluding chapter in the colorful life of a man to whom present-day rubber technologists owe a debt of gratitude. He was "Andrew H. King." It was his knowledge and enthusiasm combined largely with the adroit and good-humored persuasiveness of the late Ellwood Hendrick that led to the present open-door policies of the rubber industry. As both of these estimable members of our profession have now passed on to their reward, there is no longer need to withhold this 20-year old secret.

»Lafayette's Contribution and Tradition

LAFAYETTE COLLEGE is just as proud of its 110 years as Old Heidelberg is of its first 550. Both institutions are celebrating this year, and while no international complications and resulting headlines are involved in the events at Easton, nevertheless they carry considerable significance to engineers. For it is the seventieth anniversary of engineering instruction that holds the stage at Lafayette. Although its charter, originally framed in 1824 and granted in 1826, specifically mentioned courses in "Civil and Military Engineering," it was not until the 1865-66 college term that engineering instruction got under way. One of the first to receive the degree of mining engineer was Dr. William McMurtrie, who was chief chemist of the U. S. Department of Agriculture from 1873-78 and later became an outstanding teacher in the Middle West and a successful industrial chemist in New York. Dr. Edward Hart, who began his studies in 1874 and served his Alma Mater a full fifty years, had a tremendous influence on the development of chemical engineering in America. One of his students, Richard K. Meade, who founded the journal, *The Chemical Engineer,* in 1904, was the creative spirit that led to the establishment of the American Institute of Chemical Engineers in 1908. John T. Baker and George P. Adamson of reagent-chemicals fame and James Gayley, whose discovery of the dry-air blast brought him the Perkin medal and a vice-presidency of U. S. Steel—these are more of the names that are outstanding in chemical engineering's brief history. Lafayette has every reason to be proud of her contribution. But with it is also a clear mandate to continue to train chemical engineers worthy of Lafayette's fine tradition.



Oceans of Raw Material for Magnesium Compounds

By PAUL D. V. MANNING
Pacific Coast Editor
Chem. & Met.

OCEAN WATER, making up the great portion of the surface of the earth, has always attracted production-minded people as a source of raw material for manufacturing operations. As in many other natural processes, concentration is slowly going on and the land above water is being continuously leached by waters evaporated from the ocean and precipitated on the land.

Gold from sea water has filled the pots at the end of many rainbows and still remains at the end of the rainbows. The first great chemical industry working on sea water is of course the salt industry. Various other materials, such as bromine and magnesium chloride, are being produced from concentrated mother liquors or bitterns from the production of crude salt by solar evaporation of sea water.

Bromine was produced some years ago from sea water in a ship-housed plant which after preliminary operation was laid up as a standby threat to other producers of this element. This finally culminated in an alliance between the chief user of bromine and one of the heavy producers and resulted in the building of that marvelous plant producing bromine direct from sea water at Wilmington, N. C. (See *Chem. & Met.*, August, 1934).

A number of years ago, Robert E. Clarke of San Francisco became interested in the direct production of magnesium products from sea water. His interest developed eventually into a successful process which made use of the precipitation of magnesium salts as magnesium hydroxide by adding clarified lime water to sea water. This reaction when carried out in the dilute solutions which are made necessary by the low solubility of lime in water, on the one hand, and the low concentration of magnesium salts in sea water, on the other, never seems to fail to astound even chemical engineers who witness it for the first time.

The general impression seems to prevail that no substance contained in sea water other than salt will economically justify the cost of pumping the large quantities of water required for commercial production, even when the rest of the process is low in cost. In point of fact, it really costs very little to pump large quantities of water, as has been demonstrated on both the East and West Coasts. For the last ten years a plant, that of Marine Chemicals Co., Ltd., has been operating on the inland shores of San Francisco Bay, drawing its raw material from water which seldom averages more than 80 per cent of the normal saline content of sea water. This plant is engaged in making 22 different magnesium compounds, producing daily in the neighborhood of 10,000 lb. of various types of finished carbonates, hydroxides and oxides. In operating practice approximately 100 gal. of bay water is pumped to produce 1 lb. of MgO.

A typical analysis of the sea water used, in grams per liter, is as follows:

$NaCl$	27.319		$Ca(HCO_3)_2$	0.178
$MgCl_2$	4.176	MgO 2.2	K_2SO_4	0.869
$MgSO_4$	1.668		R_2O_3	0.022
$MgBr_2$	0.076		SiO_2	0.0076
$CaSO_4$	1.268		B_2O_3	0.0285

The water also contains traces of iodine, phosphorus, nitrogen, lithium and heavy metals as well as considerable organic matter.

Although the reaction upon which the process is based is decidedly simple namely $MgCl_2 + Ca(OH)_2 = Mg(OH)_2 + CaCl_2$, its practical application has been attained only through overcoming almost insurmountable operating difficulties and by the development of ingenious equipment and a closely controlled operating technique. The quantity of impurities allowable in all of the final products is very small. Moreover, all magnesium products of this type require extremely stringent color standards. When to these requirements is added the tendency of magnesium hydroxide to hydrate and form practically unfilterable compounds and even gels, and the tendency of the carbon dioxide content of the air to introduce further complications, it will be easy to imagine some of the troubles that afflict the production man.

Needless to say, a successful process came only after the most painstaking regimen of physico-chemical, crystallographic and engineering research. The idea of precipitating magnesium hydroxide from sea water was not new, but the fact that the water contained a multiplicity of unwanted compounds in addition to the magnesium radical, the fact that special reactivity and purity were required in the lime slurry, and that colloidal precipitates of difficult settleability were obtained, all combined to make this a most exacting piece of development. Coupled with the technical questions were many relating to consumer needs that had to be answered before the plant at South San Francisco could be built.

Treating the Sea Water

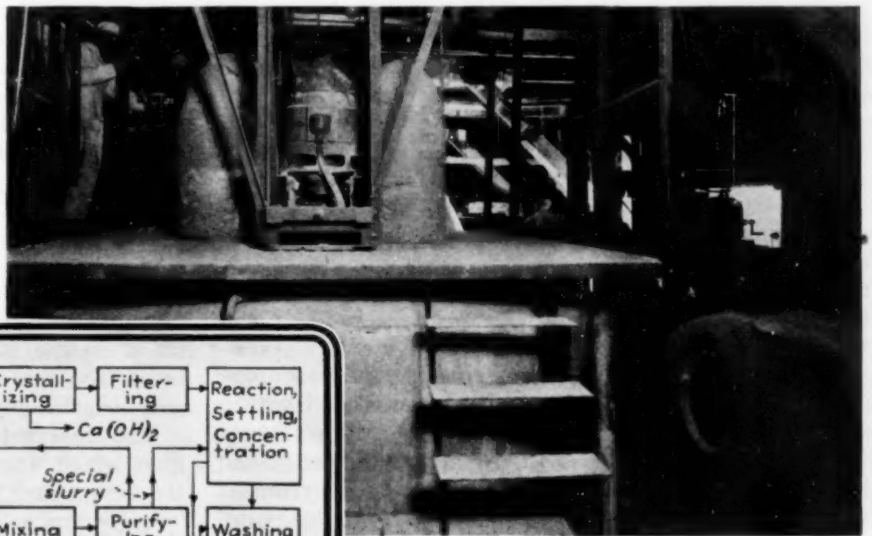
In carrying out this process, it is first necessary to free the water from all suspended impurities and from carbon dioxide in the form of bicarbonate. During the rainy season the removal of suspended matter, with its high content of colloidal clay, becomes a real problem if loss of magnesium content is to be avoided. The problem is solved at the South San Francisco plant by a series of treatments.

The water is pumped from a point about 400 ft. from the shore by means of a Byron Jackson pump through a wood pipe. As it enters the plant, it is chlorinated and then treated with a slurry of calcium hydroxide which is a waste reject slurry from the slaking process. To give time for the formation of calcium carbonate and for precipitation of the suspended solids, the treated water passes continuously into a retention tank and finally into a clarification tank where a part of the precipitated materials flows out. Crystallization of the calcium carbonate from a supersaturated solution in a specially designed continuous crystallizer has by this time taken place and the water than passes through sand filters which remove all the residual suspended material.

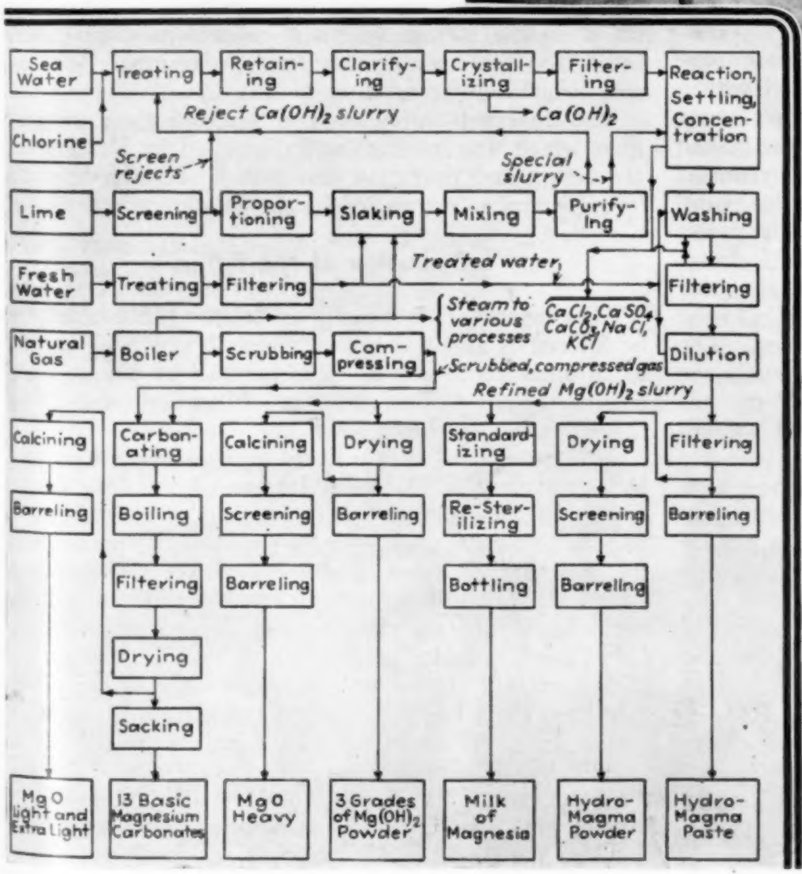
As the purified water leaves the filters it is a beautiful, sparkling

Left: Plant of Marine Chemicals Co., Ltd., with its unlimited raw material source, the waters of San Francisco Bay, in the background

Right: Top of the Peebles spray dryer, showing atomizer drive, gas pipes and automatic lubricator



Below: Condensed flow sheet indicating operations employed by Marine Chemicals Co., Ltd., in making magnesium salts from sea water



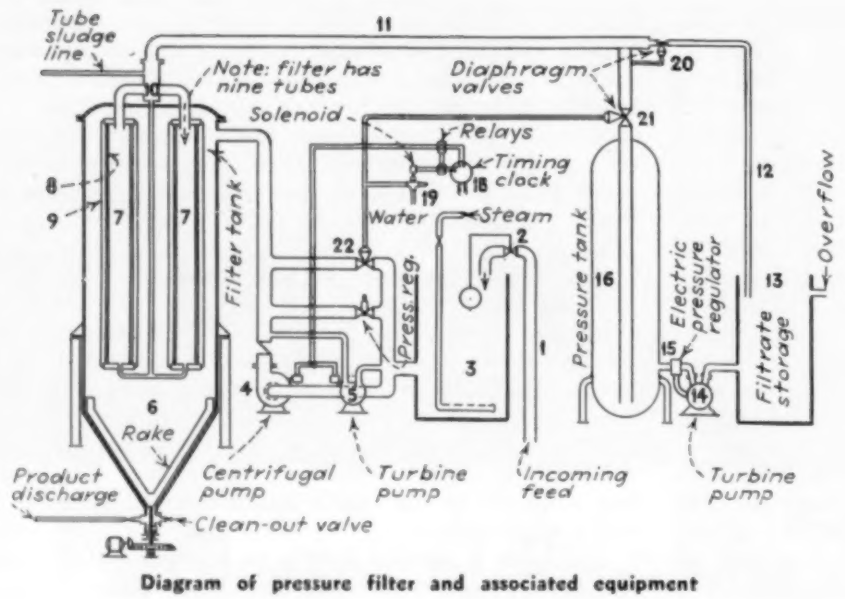


Diagram of pressure filter and associated equipment

liquid, softened, sterilized and clarified. At this point it enters a concrete storage tank. Automatic regulation controls the water passing to this tank and recording flow meters measure the quantity pumped.

Special Milk of Lime Required

The second raw material, lime, is a special high-calcium oxide. It is first screened. The reject from this screening is mixed with the slurry rejected by the slaking screen further on in the process and is used in pretreating the sea water before it enters the pretreatment tanks.

The screened oxide passes through a proportioning device to a continuous slaker where it is slaked with a small quantity of specially treated water. Mother liquor from the reaction tanks is then mixed with the slaked lime slurry and the diluted slurry is screened by means of a vibrating screen designed and built in the plant, screening to a fineness of under 200 mesh. The reject from this screening is sent to the pretreatment circuit as previously mentioned. The screened slurry is mixed in proper proportion with the clarified sea water, allowed to react and passed to an 85-ft. Dorr thickener. The magnesium hydroxide settles and concentrates while the mother liquor, containing calcium chloride, calcium sulphate, some calcium carbonate and chlorides of sodium and potassium, overflows and passes to waste.

It will here be necessary to digress long enough to bring the next raw material through its treatment up to this point in the process. Although city water is usually thought of as being quite pure, it is not pure enough for this process. It is therefore treated, filtered and heated before it enters the lime slaker and boiler and before it enters the process farther on for washing and dilution purposes.

Owing to the hydrous nature of magnesium hydroxide, it is not possible to obtain a very concentrated slurry from the thickener. The mother liquor contains chlorides of sodium and potassium which must be largely removed at this point in order to permit the production of a final product of sufficient purity. It is particularly necessary to remove the calcium chloride since its presence results in the formation of calcium carbonate and magnesium chloride during the subsequent carbonation of the magnesium hydroxide slurry and this means a loss of product and the further introduction of impurities. Successful washing of a hydrous, flocculent hydroxide slurry and its subsequent concentration are really the steps upon which the whole economical operation of the process depends. Continuous rotary filters are not feasible, for with this slurry a filter cake of greater thickness than $\frac{1}{16}$ in. is practically unknown.

The equipment and processes for handling this problem have been invented and developed largely through the efforts of H. H. Chesny, a chemical engineer and vice-president of the company.

In the washing of the thickened slurry advantage is taken of the tendency of the hydrous material to gel, and of the particles to adhere together. The slurry is pumped to the top of a tall tower. Treated city water enters the bottom of this tower and passes slowly and quietly to the top where it overflows to waste. The slurry extrudes through fine holes in the bottom of a closed receiver situated at the top of the tower, at a point below the point at which the waste wash water overflows. This extruded slurry retains its shape more or less, but breaks up into short lengths having the appearance of spaghetti, and falls gradually through the tower to the bottom where it collects in a quiet zone below the fresh water entrance. Washing is thus accomplished countercurrently by diffusion.

The collected slurry is then pumped to a pressure filter which was invented and developed by Dr. Chesny. Its design and operation can best be described by the inventor and as shown by the sketch above.

Operation of the Filters

"The operation is briefly as follows: The slurry to be filtered is supplied through pipe 1 and float valve 2 to an open wood tank 3. It is pumped by pumps 4 and 5 into the steel filter tank 6. Filtration takes place through the filter tubes 7.

"The tubes consist of a metal grill structure 8 covered by filter bags 9. The main feature of the filter design lies in the construction and dimensions of the tubes and bags which make possible the formation and particularly the discharge of a heavy cake of gel-like magnesia. A filter cake is built up on the cloth and is discharged periodically into the cone bottom of tank 6. For the filtering of colloidal precipitates, a rake is provided in the cone to aid in the continuous discharge of the solids. The rake shaft extends through the bottom of the cone and is driven by an external gear and motor reducer.

"The filtrate is discharged from the interior of tubes 7 through the manifold 10 and pipes 11 and 12 into a filtrate storage tank 13 from which it overflows. A portion of the filtrate or, where additional washing of the filter cake

is desired, fresh water, is pumped by means of pump 14 through pressure regulating valve 15 into a steel tank 16. Air is entrapped in the upper portion of tank 16 and is compressed by the rising water in the tank.

"After a filter cake of the desired thickness has been built up in filter tubes 7, which in case of a material as colloidal as magnesium hydroxide is approximately 1 in. during a cycle of seven minutes, the cake is discharged from the tubes by inflating the bags 9. This is accomplished by means of the timing device 18, consisting of a Telechron clock and two relays. One relay starts and stops pumps 4 and 5 while the other relay operates the solenoid valve 19 which in turn operates diaphragm valves 20, 21 and 22. During the filtering cycle, valve 20 is open and valves 21 and 22 are in the closed position. At the end of an adjustable filtering cycle, in our case seven minutes, the position of the diaphragm valves is reversed by the solenoid valve. Valve 22 is opened, thereby releasing the hydrostatic pressure from filter tank 6. Valve 20 is closed to prevent communication between tank 6 and filtrate storage tank 13. Valve 21 is opened causing a rush of filtrate through pipe 11 into the interior of the filter tubes 7, thereby inflating the filter bags 9. The latter breaks the filter cake and permits its discharge into the cone bottom of tank 6.

"The main difficulty of dislodging the cake from the filter cloth is overcome by the construction of tubes 7 to the extent that magnesium hydroxide can be filtered without difficulty.

"The entire operation is automatic, no attention being required except oiling of the pump motors and replacement of filter bags. In our installation, the filter bags have a life of approximately six weeks after which time pin holes develop which cause cloudy filtrate.

"Our two installations have a filter area of 300 sq.ft. and, operating on very colloidal magnesia, filter 2 lb. dry basis per hour per square foot of area. In case of somewhat less colloidal materials, even on more crystalline magnesium hydroxide, the capacity is very much greater. In case of our filter installation we are able to handle 1,000 gal. per hour when increasing the particle size of our magnesium hydroxide from 2 to 10 microns.

"The power requirement of the installation is 12 hp. inclusive of the discharge rake.

"The solid concentration of the discharge depends entirely upon the nature of the material to be handled and the filter cycle. With a seven minute cycle on very colloidal magnesia we discharge at 28 per cent solids, although we have operated on occasions at as high as 56 per cent. With a less colloidal material we expect to discharge at 50 per cent solids continuously."

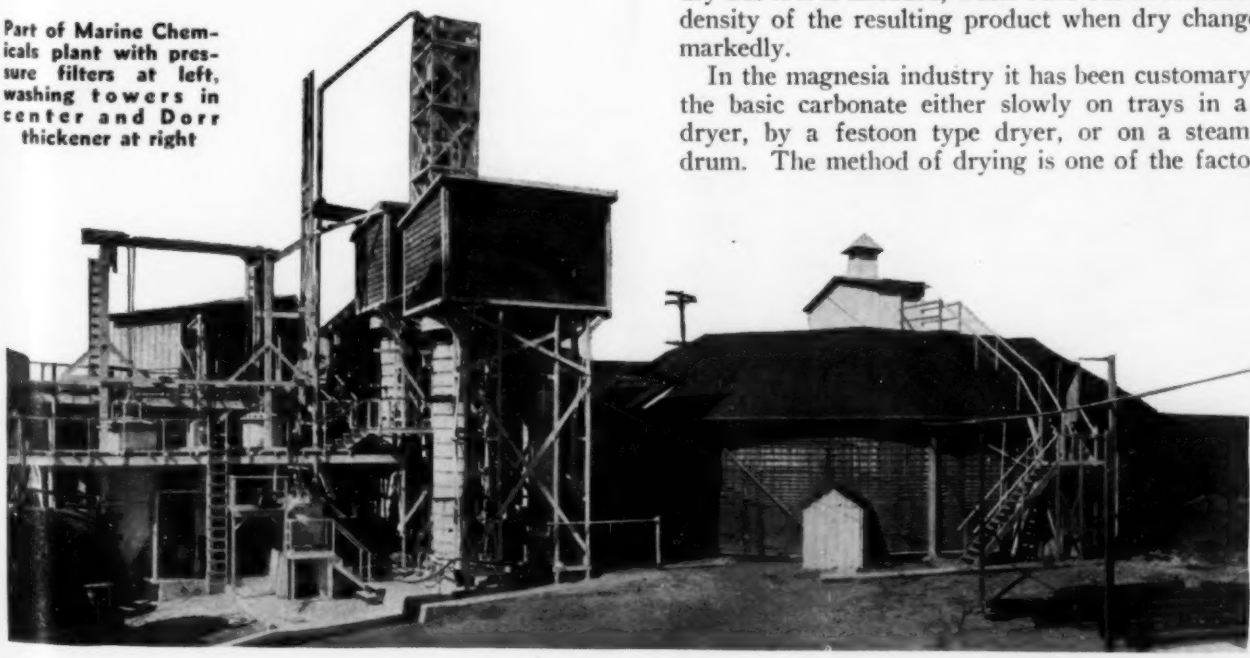
After filtering, the concentrated slurry is first diluted and then used as a stock material for the preparation of a special hydrate paste and powder, milk of magnesia, magnesium hydroxide powder and heavy magnesium oxide, all as shown by the flow sheet accompanying this article. This slurry also forms one of the raw materials for the production of the 13 different types of basic carbonate which the plant produces.

Preparing Gas for Carbonation

The other raw material is natural gas which is burned under the boiler that produces steam for process work. The cooled combustion gases are compressed in Roots type rotary compressors. The carbon dioxide content of this gas is then used to carbonate the magnesium hydroxide slurry in batch carbonators, open at the top to the atmosphere. After being properly carbonated, the slurry is "boiled" or "expanded" with steam to form the basic carbonate of desired composition. Its physical properties have now changed. It is easily filtered on an Oliver filter and a cake containing 85 per cent water and 3 in. thick is easily obtainable.

This filter cake is washed and then repulped with water. The slurry is dried. The steps of carbonation, filtration, washing and drying are most important and require exact control. A slight change in one of the many variables changes the physical properties of the resulting basic carbonate, its crystal size, shape and especially the bulk density. The filter cake seems almost dry but if it is kneaded, water runs out of it and the bulk density of the resulting product when dry changes very markedly.

In the magnesia industry it has been customary to dry the basic carbonate either slowly on trays in a tunnel dryer, by a festoon type dryer, or on a steam-heated drum. The method of drying is one of the factors hav-



Part of Marine Chemicals plant with pressure filters at left, washing towers in center and Dorr thickener at right

ing the greatest effect on the bulk density and a very low bulk density is usually one of the important items specified by the salt manufacturers who use the material to prevent caking.

The use of iron in the construction of the dryers is normally out of the question because of impurities introduced into the product through corrosion caused by the action of heat on the magnesia and any chlorides present. However, by keeping the chloride content very low, this has been avoided in the plant described here. Two types of dryer are used, single steam-heated iron rolls and the Peebles spray dryer.

The use of the roller type dryer presented some difficult problems in the removal of the dried product from the roll. This was solved by the use of rapidly rotating steel brushes which replaced the customary "doctor" bar. The capacity of this type of dryer is small and the operating costs are rather high. This caused the management to try out other types and the spray dryer was finally applied satisfactorily.

Operation of the Peebles Dryer

In this dryer, the slurry is fed to a specially designed centrifugal atomizer which atomizes it and throws the particles in a horizontal plane at right angles to the axis of a rotating vortex of incoming hot combustion gases from a furnace burning natural gas. The bulk of the water is removed as the particles of slurry pass through this vortex and the nearly dried particles are then caught in an oppositely rotating vortex of cooler air rotating around the periphery of the cylindrical drying chamber. The drying is here completed and the dried material passes out of the dessicator with the current of gas into the dust separating equipment where it is removed by bag filters. It is then classified and packed for shipment.

This drying operation is entirely controlled by automatic instruments at every point. The inlet gas temperature of approximately 1,100 deg. F. is controlled by thermostats actuating the gas supply. The outlet gas from the dessicator is controlled by increasing or decreasing the supply of liquid fed to the atomizer. In case of any trouble which the control system itself cannot correct, it shuts down the furnace, then the feed and all motors, opens the cold air inlet and sounds an alarm which calls the foreman or operator.

This dryer has lowered production costs, increased capacity and aided in the production of a uniform product.

Corrosion problems in the plant are solved by use of wood, Monel metal, high silica cement (for tank linings), glyptal lacquers and rubber.

Until about three years ago only two types of basic carbonates were known, the regular and the dense. Eight different carbonates are now made at this plant, each in several grades. These are used as coating agents for sulphur, salt, dried vegetables and other substances; the production of printing inks, coating of rubber, manufacture of pharmaceutical preparations, pastes, soaps, tooth powder, paints and varnishes.

The "hydro magma paste" serves as a convenient raw material for the preparation of milk of magnesia and dental creams.

It seems of particular interest that, in using sea water as a raw material, a number of useful products are being manufactured profitably through processes which have been soundly developed by carefully applied chemical engineering. The equipment employed is an interesting collection of apparatus adapted from what was already on the market, to which was added other apparatus developed by the technical staff of the company, mainly through the efforts of Dr. Chesny. When such equipment was needed there has been no hesitancy on the part of the management; that these efforts have resulted so successfully has been due in no small measure to the vision and sympathetic interest of R. E. Clarke.

Collection bins, mixers and sacking equipment

Why Soya Bean Oil Plants Exploded

EXPLOSIONS occurred in two soya bean oil extraction plants last October. One of these plants was owned and operated by Varnum Parish, Jr., at Momence, Ill. The owner and his assistant were killed, and two others, the plant fireman and a visitor, were injured. The unit was one of the first installations of this type on a rural community basis to be installed and operated in this section of Illinois. The explosion, which occurred about six hours after the plant had started operation, created considerable interest throughout the Middle West in the practicability of farm and rural community installations for soya bean utilization.

The second explosion caused the death of 11 men and injured 45 others. It occurred at the soya bean processing plant of the Glidden Co. at Chicago. The processing section of the plant was almost totally destroyed with a loss estimated at $600,000. Considerable glass was broken in surrounding residences and business properties. The plant was producing soya bean oil, meal, pro-

Based on articles in January issue of the National Fire Protection Association Quarterly by David J. Price, chairman of the N.F.P.A. Committee on Dust Explosion Hazards, and principal engineer in charge of the Chemical Engineering Division, Bureau of Chemistry and Soils; and Hylton R. Brown, secretary of the N.F.P.A. Committee on Dust Explosion Hazards, and engineer in Chemical Engineering Division, Bureau of Chemistry and Soils.

tein and lecithin. It had a capacity of about 4,000 bushels of beans a day.

In the investigation of the causes of this explosion consideration was given to the possible hazards present in the process used. At the elevator where the beans were received and stored the same dust explosion hazard existed that would be present in a similar elevator handling grain. In the bean preparation building where the beans were cleaned, cracked and flaked practically the same dust explosion hazard existed as in a feed mill. The extraction unit was considered the hazardous part of the plant, both by company officials and insurance inspectors, because of the use in this section of hexane for the extraction of the oil from the bean flakes. (Hexane is a light flammable liquid with flash point of 0 deg. F. or lower. The vapor is explosive in mixtures with air, with explosive limits 1.1 to 4.2 per cent, according to data from a solvent producer. The maximum rate of flame propagation occurs with a 2 per cent mixture.) At the other end of the plant in the protein building was another dust explosion hazard. At this point in the process press cake from the filter presses was broken up, dried in an oil-fired flash type dryer, ground, screened and sacked. Here again the dust explosion hazard would be similar to a feed preparation plant with the additional hazard of the oil-fired dryer.

Conclusions

In drawing conclusions attention has been given to statements of company officials regarding the process in use at the plant, as well as statements of employees concerning operating conditions before and at the time of the explosion. A study has been made of the building layout and machinery location, and the ruins have been inspected as far as possible for any evidence which would indicate the point of origin and source of the ignition.

It seems to be generally agreed by those studying the ruins that the explosion centered in the upper part of the tank building of the protein section, and the consensus of opinion is that it was an explosion of gas. The manner in which the building walls were shattered and the absence of fire following the explosion indicate that the explosive mixture was gas and air in proportions conducive to the rapid passage of flame. This opinion is upheld by the statements of employees, who said that they smelled gas before the explosion, and the fact that the manager and other officials were in the plant, endeavoring to find the source of the gas leak.

At variance with this conclusion is the fact that the only man burned in the explosion was the employee stationed at one of the flaking rolls in the bean preparation building and the evidence that the circuit breaker of the motor on one of the flaking rolls had opened four or five times during the morning. He thought he might have been burned by a flash of flame from the motor, but feels that the big explosion came from the protein building.

The problem in the investigation has been to determine how the gas accumulated in the tank building and how it became ignited. From the evidence assembled it is the opinion that gas from the extraction building passed into the tank building at or near the top of the fire wall separating the two units, or possibly through the pipe carrying condenser water into the tank building. The tank building, a large open area without floors in its 50 ft. height, had little or no ventilation because the weather was cool and windows had not been opened. Probably a large pocket of gas accumulated at that point. The gas could have been ignited when the flash occurred at the flaking roll. In fact, it is quite likely that the burns received by the employee at the flaking roll were received in a mild or minor dust explosion at that point. This flash, passing through the doorway between the bean preparation building and the tank building, could have been the source of ignition for the main explosion which wrecked the plant. It is also possible that gas was present in the bean preparation building as well as in the tank building, and that the motor circuit breaker opening or a flash at the roll provided a direct ignition for the gas and air mixture.

Recommendations for Explosion Prevention

As a result of the study of the process made in connection with this investigation it is recommended that certain precautions should be taken in plants of this kind to guard against dust explosions as well as vapor explosions.

1. In elevators handling soya beans, the safety code for the prevention of dust explosions in grain elevators as prepared by the Dust Explosion Hazards Committee of the National Fire Protection Association should be followed.

2. In plants grinding or milling soya beans or preparing them for processing, the safety code prepared by the same committee for the prevention of dust explosions in flour and feed mills should be followed.

3. Soya bean elevators and buildings in which grinding, milling or other preparatory processes are performed should be segregated from other sections of the plant, and should have vents in the walls or roof to release explosion pressures without structural damage. Such vents, in the form of hinged sash or light panels, should have an area of 1 sq.ft. for each 80 cu.ft. of the building, room or bin.

4. The same precautions suggested for soya bean milling or preparation units should be adopted in plants preparing protein from soya beans, particularly in the drying section.

5. Dryers in all parts of a plant where flammable dust is present should be separated from other sections of the plant, and the outside walls should be equipped with the above recommended amount of venting facilities.

6. Dust collectors should be installed outside or vented outside of the building.

7. To guard against any inherent dust explosion hazard, special attention should be given to the type of dryer used.

8. In soya bean processing plants using the extraction process all possible precautions should be taken to provide for the safe operation of such units, because the solvents generally employed constitute a fire and explosion hazard.

9. Where hazardous solvents are used consideration should be given to the practicability of installing instruments which will detect the presence of flammable vapors and give warning when the concentration approaches the lower explosive limits.

10. Attention should be given to the development of a non-flammable solvent for use in such processes.

Producing Hydrogen by Catalytic Water Gas Reaction

Intensive application of hydrogenation processes for the manufacture of synthetic ammonia, motor fuels and lubricants in recent years has focussed attention on efficient processes for producing hydrogen and hydrogen-nitrogen mixtures. The author, who has specialized in high-pressure processes of hydrogenation, is particularly well qualified to discuss the method of hydrogen production which is described herein.—Editor.

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IN THE PERIOD since the War, industrial development of hydrogenation processes for ammonia synthesis and the manufacture of motor fuels from coal, tar and other hydrocarbons has resulted in the development of new methods for the production of the gases required for synthesis. Particularly have processes starting with coke oven gas or methane become important but, at present, interest has revived in the well known water gas reaction for the catalytic conversion of carbon monoxide into carbon dioxide and hydrogen through the action of steam. This process is now the sole source of hydrogen in the large fertilizer plants of the German I. G., and for the ammonia synthesis of the British Imperial Chemical Industries, as well as for many other important producers. But as well known as the various processes are, there is a lack of information readily available to the buyer as well as to the operator of such plants whereby reliable comparisons of the efficiencies, operating costs and other factors of the various processes can be made.

It is the intention of the present paper to supply data and details of the catalytic water gas or contact process whereby a part, at least, of the existing gap in the literature will be filled. The information to be given is based on theoretical investigations and practical experiences in connection with a large number of units of different capacities and various designs. Since plant of this type may be supplied with raw gases of widely varying composition, our first concern will be to discuss the method of calculating the composition of the converted gas produced with any particular raw material.

Hydrogen production by the contact water gas process consists in the treatment of CO (either in the pure state, or as one component of a mixture) with steam, in the presence of a suitable catalyst, at temperatures in the range from 400 to 600 deg. C. The reaction is the familiar one:

$$CO + H_2O \rightleftharpoons CO_2 + H_2 + W \qquad (1)$$

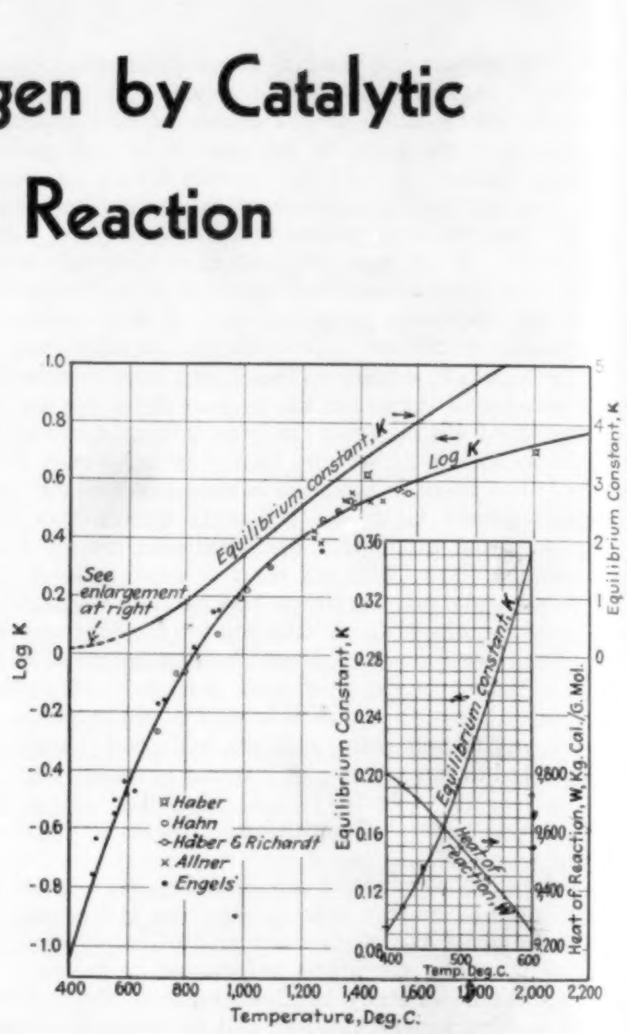


Fig. 1—Equilibrium constant and heat of reaction for water gas reaction at various temperatures

where W is the heat of reaction liberated per mol of CO converted. In the case of any reaction where components A and B react reversibly to yield C and D, the conditions at equilibrium may be expressed by the relation

$$\frac{a\,.\,b}{c\,.\,d} = K \qquad (2)$$

where a, b, c and d represent the number of mols (or the partial pressures) of the several components, A, B, C and D present in the mixture at equilibrium, and K is the reaction constant at the particular temperature of the reaction. For the reaction involved in this discussion the values of K are given by Fig. 1. One curve records the experimentally determined values of log K according to various investigators. At the higher temperatures it has been possible to derive a K curve from the plot of log K. In the commercially interesting temperature range, however, 400-600 deg. C., the log K curve is not well enough defined to permit direct derivation. It has therefore been necessary to integrate graphically the expression $d\,(\ln K)/dT = W/RT^2$ (which is the fundamental relation expressing the variation of K with T) to determine the integration constant in the equation $K = f(T) - C$. The value of C has been determined in the range from 800 to 1,400 deg. C. where the slope of the log K curve is well defined. With C known it has been possible to extend the K curve to the left, as shown in the dotted range and in the enlarged insert. In the integration the variation of W with temperature has been determined graphically using the most reliable of present data for the variation of specific heats with temperature. Values of W, it will be noted, have been plotted in the insert. Both large scale laboratory and plant tests have demonstrated the correctness of these factors as given.

Knowing K, which it has been shown depends only on the tem-

perature at which the reaction is carried out, it is possible to compute the composition of the converted gas, with any sort of gas mixture used as the raw material. The calculation assumes that the components act as perfect gases, but there will be no appreciable error in the assumption, provided that the reaction is carried out at low pressure, as it generally is.

The composition of the raw gas will ordinarily be expressed on a volume per cent basis, but for purposes of calculation it is convenient to deal with a volume of raw gas which contains 1 mol of CO. Thus, a producer gas containing 40 per cent CO, 50 per cent H_2 and 5 per cent each of CO_2 and inert gases may be considered to contain for each mol of CO, 1.25 mol of H_2 and 0.125 mol each of CO_2 and inert ingredients. Putting the raw gas composition into more general terms, we can state that the gas contains, for each mol of CO, c mol of CO_2, d mol of H_2 and e mol of inert ingredients. For the reaction we shall supply b mol of steam. Having started with 1 mol of CO, we find, at equilibrium, that x mol of CO has been converted into CO_2. Therefore, the final mixture will contain $(1 - x)$ mol of CO, $(b - x)$ mol of H_2O, $(c + x)$ mol of CO_2, $(d + x)$ mol of H_2 and e mol of inert gases. Substituting these several values in equation (2), we obtain the following:

$$\frac{(1 - x)\,(b - x)}{(c + x)\,(d + x)} = K \tag{3}$$

Solving for x we obtain the quadratic:

$$x^2 - \frac{(b + 1) + (c + d)\,K}{1 - K}\,x + \frac{b - cd\,K}{1 - K} = 0 \tag{4}$$

where, as noted above, x is the fraction of a mol of CO converted per original mol of CO (percentage conversion ÷ 100), b is the number of mols of steam used (steam-CO ratio), c and d are the numbers of mols of CO_2 and H_2 associated with each original mol of CO, and K is the equilibrium constant at the temperature of the reaction.

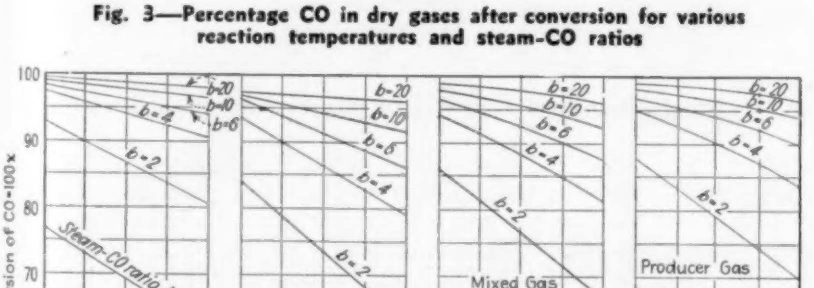
A number of deductions may be drawn from these several equations to assist in the evaluation of results to be obtained from the water gas reaction. First, since the total pressure of the reaction does not appear, the reaction is evidently independent of the total pressure and no advantage will be gained in working at elevated pressure (assuming the gases to be perfect). Nor does the content of inert gases appear, so that their presence will have no effect on the degree of conversion obtained. As a matter of fact, however, such gases do dilute the reacting components and decrease the reaction velocity. Then, it will be evident that various means can be employed to influence both the composition of the converted gases and the degree of conversion. For instance, with increasing temperature of the reaction, the degree of conversion will decrease, regardless of the composition of the raw gases. But at any one temperature, with K fixed, a change in the partial pressure of one of the component gases will affect the partial pressures of the remaining components. Thus, if an excess of steam is used, the equilibrium of equation (1) will be displaced toward the right; and the same result can be attained by the elimination of the CO_2 and/or H_2 produced by the reaction at the moment of formation. Conversely, the addition of H_2 or CO_2 during the reaction will result in diminution of the conversion.

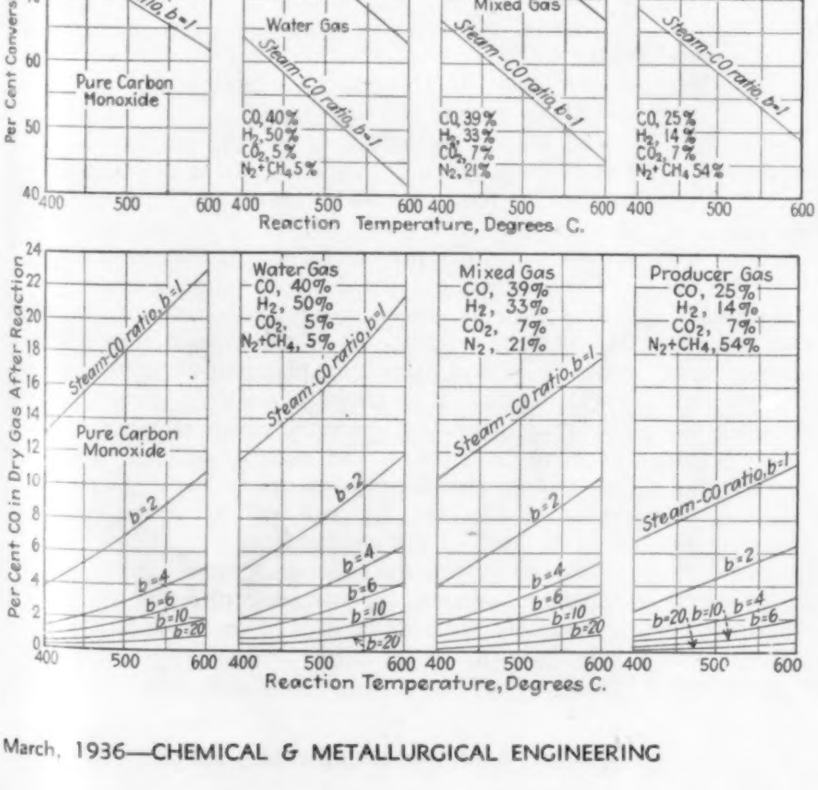
In actual operation the ordinary contact conversion process does employ excess steam to favor the conversion, while the high-pressure contact process and several special conversion processes use both excess steam and the elimination of CO_2 during the reaction. Elimination of H_2 during conversion has not yet been practiced.

Substitution of the values for K and the b, c and d coefficients for any particular raw gas into equation (4) makes it possible readily to determine the percentage conversion that will be obtained in any particular case. This has been done in Figs. 2 and 3 for several sorts of raw gas, including pure CO, water gas, a mixed gas and producer gas. Fig. 2 gives the percentage conversion to be obtained with various excesses of steam at temperatures of 400-600 deg. C. Fig. 3 gives the per cent CO in the dry gas resulting from the conversion at the various temperatures and for the various steam percentages. The CO percentage has been derived from the relation: per cent CO = $100\,(1 - x)/(1 + x + c + d + e)$.

Fig. 2—Percentage conversion of CO at various temperatures for various steam-CO ratios

Fig. 3—Percentage CO in dry gases after conversion for various reaction temperatures and steam-CO ratios





A Typical Plant

A typical plant for carrying out the catalytic water gas process is shown diagrammatically in Fig. 4. The system consists of a saturator, heat exchangers, reaction vessels, or converters, and coolers. In most cases the gas is properly cleaned and freed from sulphur compounds before entering the saturator. It is generally supplied to the latter at a pressure of 800-1,300 mm. w.g., with the booster usually ahead of the purifier. The booster may be driven by either an electric motor or a steam turbine, the latter being advantageous in large plants where exhaust steam from the turbine may be used in the process. In the saturator the gas is heated to 75-85 deg. C. in contact with the counter-flowing hot water and at the same time supersaturated by 1-3 per cent owing to spray carried off with the gas flow. The saturator is generally a fairly large tower, electrically welded or riveted and filled with porcelain or stoneware packing of 60-100 mm. diameter. Wooden and iron

distribution plates or grids and baffles of special design are also used.

Gas leaving the saturator carries insufficient steam for satisfactory conversion and additional steam up to 5-6 times the theoretical volume (about 50 per cent of the total steam required) is added before the gas enters the first heat exchanger. This may be exhaust steam, or if only live steam is available, the latter may be added in a steam jet compressor. From the standpoint of compression efficiency, it would be more effective to use a turbine-driven compressor, adding the exhaust steam to the gas stream.

The steam-gas mixture passes through the two heat exchangers outside the tubes, going thence to the first converter. The incompletely converted gas discharges through exchanger II, passing to the second reaction vessel and discharging through exchanger I, from which it passes to the primary cooler. Temperature of the gases entering the reaction vessels is controlled by the direct admission of raw gas or by bypassing one or both of the heat exchangers. It is also possible to admit steam direct to the converters. For a very efficient catalyst the admission temperature to the first reaction vessel may be as low as 400 deg. C. For the more robust catalysts used for working up the less pure gases, the starting temperature may be as high as 470-480 deg. C. In the first converter the reaction takes place at steadily increasing temperature owing to the liberation of heat of reaction. For ordinary practice in ammonia synthesis plants, the increase in temperature lies between 100 and 120 deg. C. in the first converter, the gases leaving with a CO content of 4-6 per cent, dry basis. Before entering the second converter the gases are cooled in heat exchanger II to 420-450 deg. C. Owing to the small quantity of carbon monoxide remaining at this point, the increase in temperature in the second converter is only about 5-10 deg. C., the gases leaving with 2-3 per cent CO.

Process Efficiency Depends on Heat Recovery

The heat exchangers and heat recovery apparatus in a contact plant are extremely important in determining the plant efficiency. Exchangers are generally of two or three parts to simplify cleaning and provided with baffle plates or distributing nozzles to insure proper gas distribution. It is difficult to calculate the optimum economical size of exchangers since those of very high efficiency cause a great pressure loss and decrease the efficiency of steam generation. The overall coefficient of heat transfer from raw gas to converted gas has been found to be in the range of 15-20 Cal. per square meter, hour and deg. C. of temperature difference between raw and converted gases. Most exchangers have been designed for a 30-50 per cent higher heat transfer coefficient inside the tubes than outside. Coefficients outside the tubes vary between 20 and 35 Cal. per square meter, hour and deg. C. These figures are average coefficients taken from observations and calculations of some 30 units of different capacities and design. Particularly in gases operating on a low percentage of carbon monoxide, in which the reaction heat is small, the heat exchangers and interconnecting piping must be most carefully insulated to avoid large heat loss and the possibility of upsetting the operation of the plant.

The converters are generally cylindrical vessels placed either horizontally or vertically. They are made of mild steel riveted or welded or of cast iron, with the shell protected frequently by a firebrick lining. Special care must be taken in packing to avoid bypassing of gas at the circumference. Tops and bottoms of the vessels are also generally lined with firebrick. Usually a fairly thick layer of insulating material is put between the bricks and the wall. The vessel contains grids for supporting the catalyst which is ordinarily arranged in three to five layers. This assures better gas distribution than would be obtained with a single mass of catalyst. Ordinarily the second converter is somewhat larger than the first owing to the reduced reaction velocity obtained with the weaker gas. It frequently contains more catalyst and sometimes a more efficient one.

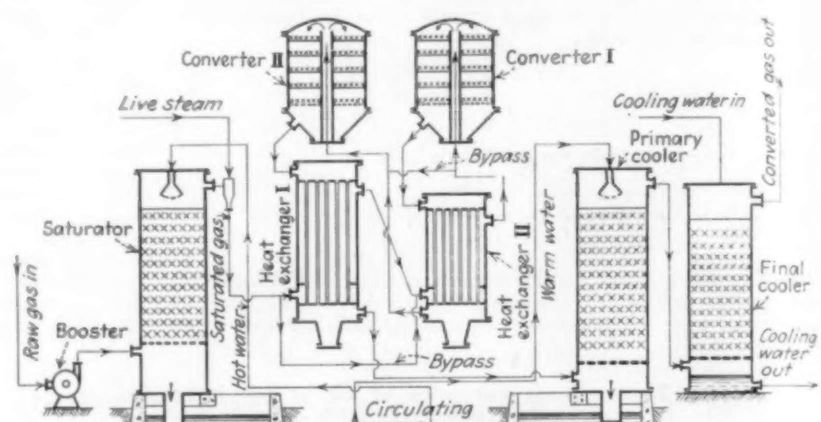


Fig. 4—Diagram of equipment for catalytic water gas conversion

The higher the efficiency of the catalyst used, the less reaction space is required. In ammonia synthesis practice the reaction vessels contain 12-18 cu.m. per 1,000 cu.m. of dry gas per hour. The second converter is generally 15 to 20 per cent larger than the first.

The catalyst consists of iron oxide containing promoters such as chromium and is activated by a special treatment before use. It is compressed into pellets or cubes or broken from thin plates in order to present a large surface. It is made in a highly porous form by employing a binding material which is removed under operating conditions. The quantity of catalyst required per unit of gas depends on many factors, but on the average 6,000-9,000 kg. will suffice for the conversion of 1,000 cu.m. of dry gas per hour.

After conversion the gases pass through the second heat exchanger and enter the primary cooler which is irrigated continuously with water withdrawn from the reservoir at the base of the saturator. Since the primary cooler, operating in conjunction with the saturator, has to re-

generate the excess steam remaining after conversion, it is evident that the efficient operation of this portion of the plant has a most important bearing on the cost of operation. By care in design, the temperature difference between the warm water entering the primary cooler and the gas leaving it may be as low as 2-3 deg. C. Leaving this tower gas passes through a final cooler on its way to storage where it is brought in contact with cold water, cooled to 25-30 deg. C. and super-saturated to the extent of 3-5 per cent.

Effect of Steam Regeneration

The importance of efficient regeneration of the steam can be demonstrated with reference to actual plant operating figures. Gas saturated in the saturator at 830 mm. Hg absolute and 87 deg. C. will remove from the circulating water inside the saturator 1,030 grams of water vapor per cubic meter of dry gas at standard conditions. This figure will decrease to 910 grams at 85 deg. C. In the primary cooler, operating ordinarily at 775 mm. Hg and 74 deg. C. outlet temperature, 1 cu.m. of dry gas at standard conditions will carry off 450 grams of water vapor which would be lost in the final cooler. Should the outlet temperature rise to 76 deg. C., this amount would increase to 517 grams. Such a loss exists even with a temperature difference between water and gas as low as 2.5 deg. C. When it is considered, further, that the total volume of dry gas is increased by the reaction by about 35 per cent, then it is evident that 607.5 grams of steam per cubic meter of dry raw gas at standard conditions will be lost even under the most favorable conditions. This amounts to 60 per cent of the steam regenerated in the saturator, a figure which would increase to 77 per cent if the saturator and primary cooler required but 2 deg. higher temperature difference between water and gas. Under the best conditions about 55 per cent of the total steam entering the plant is recovered in the saturator. About 45 per cent must be added as make-up steam. The actual consumption of steam in the reaction is about 15 per cent of the total weight, and the loss about 30 per cent of the total.

Assuming that six times the theoretical weight of steam is used, pure CO, water gas, mixed gas and producer gas (analyses for which are given in Figs. 2 and 3) would require, per cubic meter of gas at standard conditions, 4.82 kg., 1.93 kg., 1.88 kg., and 1.21 kg. of steam for conversion. The corresponding saturation temperatures at 820 mm. Hg absolute would be 98.5, 92.5, 92.4, and 88.0 deg. C., but these temperatures could only be reached with large quantities of water at a temperature near 100 deg. C. available for adding at the top of the saturator. Condensation and cooling of the gas mixture leaving the primary cooler under normal conditions consumes 25-35 cu.m. of fresh cooling water per 1,000 cu.m. of converted gas.

Starting a plant requires the use of a special combustion chamber. If the catalyst composition permits, the combustion gases may be drawn through the converters by an exhauster which is generally installed at the top of the final cooler. Often hot air is used for heating up the catalyst to about 150-200 deg. C. and when superheated steam is available, this may be used alone or in combination with hot air or combustion gases. Once the starting temperature of the catalyst is reached in at least one reaction vessel, gas may be admitted at a low rate together with steam to heat up the exchangers, pipes and converters. Sufficient gas must be admitted to increase the temperature of the catalyst and to cover the heat loss of the plant. Eventually it will be possible to put the combustion chamber out of operation. When the gas and steam are first introduced into the converters, strictest control of the temperature in each catalyst layer is essential. Non-homogeneity of the catalyst mass and unequal distribution of the gas flow may permit the development of hot spots which must be prevented by the addition of large quantities of steam or by reduction of the gas flow rate. Otherwise parts of the catalyst may be rendered inactive. Numerous thermocouples inserted in the catalyst mass permit perfect control of the temperature of the whole mass.

Once the plant is in operation and the most favorable reaction temperature, best ratio of gas to steam and maximum capacity have been determined, very little further attention is necessary provided the proper control instruments are at hand.

So far as the influence of temperature is concerned, the percentage of gas converted depends entirely on the temperature in the second converter. It is therefore of some practical advantage to have a steadily increasing temperature in the first converter, owing to the fact that the reaction velocity increases rapidly with the temperature and hence the converter can be smaller and the quantity of catalyst less than would otherwise be required. The outlet temperature of the second converter, however, should be low in order to give the required degree of conversion or to permit decreasing the quantity of steam employed. These relations will be evident from a study of Fig. 2.

Table I—Characteristics of Various Raw Gases Upon Conversion

(Raw gas analyses as in Fig. 2; data based on calculated results at equilibrium, employing steam — CO ratio of 6 and maximum temperature in second converter of 450 deg. C.)

Raw Gas	Per Cent Conversion	Final Volume at S.C., Per Cent	Composition of Converted Gas Dry Basis, Per Cent CO	CO_2	H_2	Inert
Pure Hydrogen Production						
Pure CO	97.0	197.0	1.2	49.4	49.4	.....
Water Gas	94.0	137.6	1.65	31.25	63.45	3.65
Nitrogen-Hydrogen Mixtures						
Mixed Gas	94.5	136.8	1.53	32.1	51.04	15.33
Producer Gas	95.7	124.4	0.89	24.3	29.36	45.38

Results of Conversion

Table I presents the calculated values of the percentage conversion and the composition of the converted gases that will be obtained at equilibrium with the various raw gases, the analyses of which are given in Fig. 2. It is assumed that the steam-CO ratio is 6 and that the highest temperature in the second converter is 450 deg. C. These figures will not be obtained in practice, the actual results on the average being about 1 per cent higher. The column labeled "Final Volume at S. C." shows the percentage increase in volume at standard conditions which the dry, raw gases undergo during conversion.

Pure carbon monoxide, which is rarely converted and then only in small units, yields about one volume of

hydrogen for each original volume of CO after the removal of the CO_2. After absorption of the CO_2 water gas yields about 0.94-0.96 cu.m. of H_2 of 92-95 per cent purity for each original cubic meter of CO. Under the same conditions the mixed gas referred to will yield 0.93-0.94 cu.m. of mixed gas for ammonia synthesis, containing 77 per cent H_2 and 23 per cent N_2. The exact ratio must be adjusted by the addition of pure nitrogen. Producer gas, the use of which is on the increase in fertilizer plants originally based on electrolytic hydrogen, will result in a converted and purified gas containing 38-40 per cent H_2 and 60 per cent N_2. Correction of the analysis before conversion to ammonia will require the addition of a large quantity of hydrogen to the gas mixture so obtained.

Absorption of Carbon Dioxide

The absorption of carbon dioxide from the finished gas has been referred to above. This is generally accomplished either by absorption in water or in solutions of ammonia. The method most employed is to scrub the gas in an absorption tower with water at a pressure of about 25 atm., after the third stage of the high pressure compressor used for ammonia synthesis. The gas coming from the absorber will contain about 1 per cent CO_2 which, together with the remainder of the CO, has to

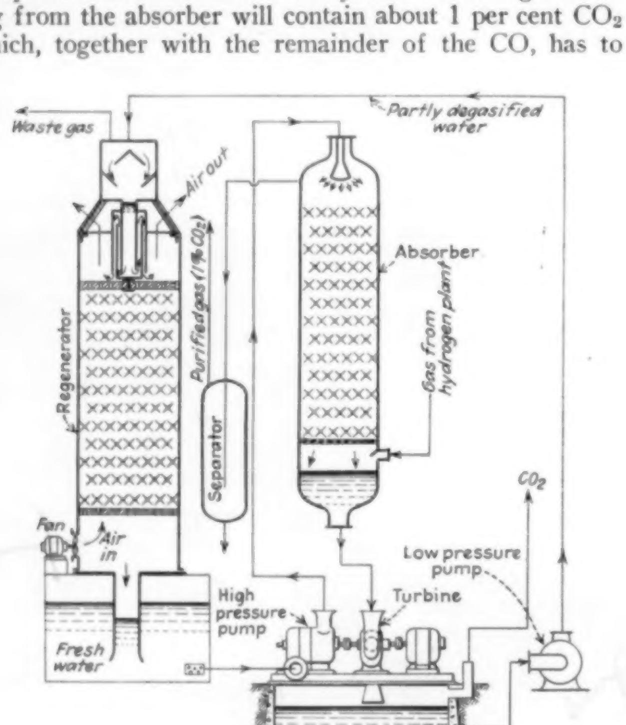


Fig. 5—Diagram of equipment for carbon dioxide absorption

be removed before conversion to ammonia. Fig. 5 is a diagrammatic representation of an ordinary absorption plant for CO_2, using water as the absorbent and a turbine to regenerate a part of the energy required for pumping. After discharge the partly degasified water is passed down a packed tower counter to a current of air which strips out the remaining CO_2 so that the water may be reused.

Data presented below, based on actual operation, make possible the calculation of the cost of a gas suitable for ammonia synthesis. The calculation is carried out for German conditions, assuming a single unit to handle 5,000 cu.m. of mixed gas per hour. The converted gas is to be freed from CO_2 by water scrubbing at a pressure of 25 atm. The costs for removing final traces of CO_2 are not included since they vary considerably depending on the method used. The following costs and rates apply:

It is assumed that one operator per shift can operate both units. Depreciation of both plants is based on a 12-year life. Interest is taken at 8 per cent, operation at 8,000 hours per year and administration costs at 75 per cent of total wages and salaries. Power and services are taken as: 2.5 pfg. per kilowatt-hour; 4.0 pfg. per cubic meter of cooling water; 3.5 RM per 1,000 kg. steam at 3 atm. In the converter plant the cost of equipment and building ready for operation is taken as 320,000 RM; the energy for compression and pumping as 1.04 kw.-hr. per 100 cu.m. of mixed gas; total steam consumption including starting and heating in winter as 0.92 kg. steam per cubic meter of mixed gas; and water

Table II—Costs of Producing Nitrogen-Hydrogen Mixtures for Ammonia Synthesis

(Exclusive of cost of raw mixed gas)

Item	Converter Plant, RM per Hour	Absorption Plant, RM per Hour
Capital service	5.30	3.46
Total energy	1.30	38.50
Steam	16.10	......
Water	8.40	0.80
Changing and cleaning catalyst	0.95	......
Wages and salaries	2.60	1.50
Maintenance	1.10	1.40
Administration	1.95	1.14
Total costs per hour	37.70	46.80

consumption as 4.2 cu.m. per 100 cu.m. of mixed gas. In the absorption plant the cost of all equipment (including a share of the high pressure compressor) is taken as 210,000 RM; the energy for compression as 18 kw.-hr. per 100 cu.m. of converted gas; the water for absorption as 6.5 cu.m. per 100 cu.m. of converted gas; and the water for replacement of losses, cooling, cleaning, etc., as 0.29 cu.m. per 100 cu.m. of converted gas. With the energy regenerated by the water turbine as 55 per cent of the total energy required to inject the circulating water at the top of the absorber, the total energy for circulation of the absorption water is 0.6 kw.-hr. per cubic meter of water.

By making use of these figures, Table II has been prepared, covering all costs except that of the raw mixed gas. It is evident that the cost, exclusive of the raw gas, will be 0.75 pfg. per cubic meter of mixed gas for the converter plant and 0.94 pfg. per cubic meter of mixed gas for the absorption plant. Since 0.94 cu.m. of synthesis gas results from 1 cu.m. of mixed gas the cost in pfennigs per cubic meter of synthesis gas at standard conditions, but available at 25 atm. and 25 deg. C., may be taken as (0.75 plus 0.94 plus cost per cubic meter of raw gas)/0.94.

It will be clearly evident from the tabulation that the big element of cost in conversion is steam and that savings must come from a sufficient regeneration. In the absorption plant compression and pumping are the costly items and even slightly lower cost for power will produce considerable savings in the cost of absorption.

Above: Bacteriological laboratory. Below: Engineering design and drafting room

RESEARCH IN A GLASS HOUSE

Within the translucent glass-block walls of the world's first all-glass, windowless structure, the research staff of the Owen-Illinois Glass Co. at Toledo, Ohio, is now equipped to study problems in the packaging field and other new industrial applications of glass. To house five separate laboratories in this two-story, 39-room structure required the use of 80,000 hollow water-clear glass blocks. These weigh less than four pounds per block or 15 lb. per sq.ft. and were laid up by ordinary brick masons. Because of the absence of windows and the resistance of the glass-block walls to heat loss and cold penetration, the entire building can be completely and economically air conditioned.

Unique architectural design made possible by glass-brick construction

CIGARETTE INDUSTRY RULES OUT

By R. M. CONE, W. H. HATCHER and W. F. GREENWALD

Respectively
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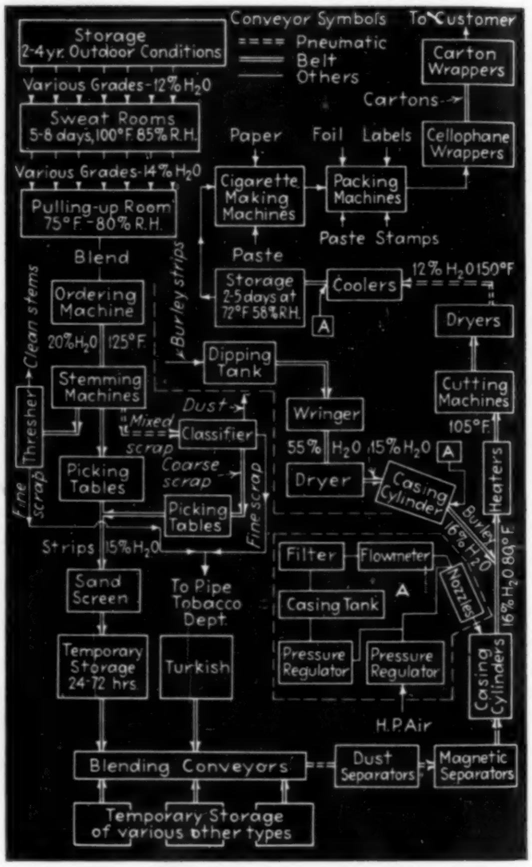


TECHNICAL PROGRESS is no more evident in any other branch of chemical industry than in cigarette manufacture where in recent years the rule-of-thumb methods of the "old timers" have given way to the most careful technical control. Cigarette making today, as exemplified in the Philip Morris plant, consists of a series of related operations, closely supervised and constantly improved by the chemical and engineering departments. Maintaining proper moisture content in the tobacco at every stage in the manufacture is the most important single factor in this control, and that in which some of the most interesting improvements have been made. On the other hand, control of flow and quality of all materials is essential to coordinated manufacture and to the production of a satisfactory product.

Leaf tobacco cannot be handled without breakage unless it contains over 14 per cent water; and it cannot be stored without molding if the water exceeds 13 per cent. A variation of a half per cent from the optimum will seriously impair the efficiency of the cigarette machines. Cigarette manufacture, therefore, must be a cycle of drying and humidifying, regardless of what else may be involved.

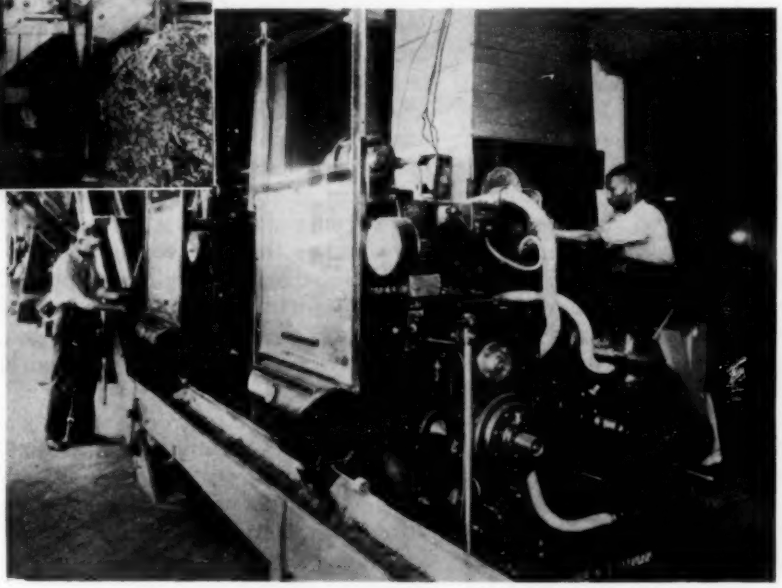
As leaf tobacco is received from the storage warehouses, it contains not over 12 per cent water. It has been forced into the hogsheads under hydraulic pressure. To separate this tight mass without making chaff of it, the hogsheads are first stored about a week in an atmosphere of the maximum temperature and humidity which will not damage the tobacco—up to 110 deg. F. and 90 per cent relative humidity. These conditions are conveniently provided by spraying a mist of warm water from high-pressure nozzles, and furnishing rapid air circulation over enough surface of space heaters to evaporate the mist before it can settle.

On leaving the "sweat room," the casks or hogsheads are removed and the mass of tobacco rolled on a movable platform into the conditioned "pulling up room," where a high humidity is also maintained, but at temperatures more suitable for human comfort. The bundles of tobacco are pulled loose from the mass with little breakage and sent through an "ordering machine" to raise the moisture content to a value high enough for the most efficient stemming (20—25 per cent). Such a machine, handling 10,000 lb. an hour, may consist of a series of bronze wire baskets, moving on an endless conveyor through a long tunnel of stainless steel, in which moist air and wet steam are blown on the tobacco. The baskets discharge automatically on a conveyor feeding the stemming machines.

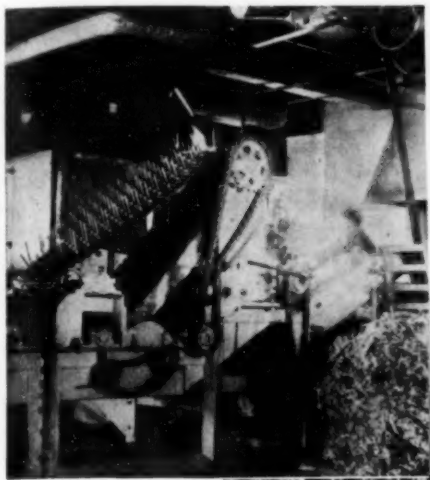
The thick, woody midrib of the leaf (the "stem") is highly undesirable as a constituent of cigarette and pipe tobacco and should be removed. In most types of machine, the leaf is torn away at the butt of the stem, producing a small percentage of scrap. The butt is grasped by a series of fingers or between two belts and the leaf drawn between a set of wire teeth. The stem, retained by its conveyor, is pulled out of the remainder of the leaf, which is then dropped. The stems are discharged to one belt conveyor, the scrap to another below the butt cleaner, and the stemmed leaves (the "strips") to a third. If the leaf is as pliable as a damp cotton rag, this operation can be accomplished with a minimum of breakage; otherwise an excessive quantity of scrap is produced.

The strips are discharged on wide, slowly moving conveyors on which any foreign matter, stems, unstemmed leaves, or undesirable tobacco may be picked out by hand. They are then tumbled through a revolving screen to remove loose sand and fine particles of tobacco and finally collected on movable trucks for temporary storage. The atmosphere of the stemming and cleaning

RULE-OF-THUMB



Below: Self-sharpening cutting machines for cigarette tobacco



Dipping trough for Burley tobacco

Left: Flow chart of operations in the manufacture of Philip Morris cigarettes

rooms is kept at such a humidity that the strips after stemming lose about 7 per cent moisture in process (23 to 16 per cent) but if the tobacco is to be stored more than a few days it must be redried down to about 12 per cent.

What scrap is produced in the stemming machines is picked up by a pneumatic conveyor, then freed from dust and sand by air separators and finally graded on screens by sizes. The larger pieces suitable for cigarette tobacco are returned (after picking) to the strips in the same proportion that the machines produce the scrap and the smaller pieces are used in pipe mixtures. The stems go through a threshing machine to remove any fine tobacco not taken off in the stemming machines and the clean stems are sold to insecticide and fertilizer manufacturers.

Domestic tobaccos of the various types and general grades (flue-cured, from several districts, Burley, Maryland tobacco, etc.) are usually stemmed separately, but the blending practice described below is that in use at the Philip Morris plant, and may not be general. A long, wide conveyor is provided with a series of rotating rakes which maintain a constant level of tobacco under them. Going down the conveyor toward the discharge end, they are set successively higher. Weighed portions of the various types are assembled on both sides of the belt and fed on at such a rate that the tobacco does not pile up excessively behind the rakes. In front of the first rake Burley may be applied, between the first and second Turkish, next some grade of bright flue-cured, and so on. This arrangement maintains a uniform feed of each type, and a uniform feed of the blend to the next process. The blending belt discharges into a pneumatic dust separator, which in turn drops the tobacco into a pneumatic conveyor from the stemmery to the factory proper.

Up to this point the tobacco has received no treatment to alter its natural hygroscopicity, and to prevent excessive drying the relative humidity has been kept above 70 per cent. It would be possible to cut the tobacco and make satisfactory cigarettes without further treatment, but the cigarettes would soon become much too dry in the atmosphere of most parts of the United States. The equilibrium relative humidity for an average cigarette blend at 70 deg. F. and 12 per cent water is about 68 per cent; in order to reduce this to about 55 per cent (an average for the American climates) it is necessary to add to the tobacco some more hygroscopic substance. Such a substance should be combustible, non-toxic, and odorless and should contribute nothing deleterious to the smoke.

In the past, millions of pounds of glycerine have been used for this purpose. More recently diethylene glycol has come into use in the cigarette and pipe tobaccos made by this company, with the interesting results outlined below.

Use of diethylene glycol in place of glycerine constitutes one of the major advances in recent years in the manufacture of cigarettes. Its use was suggested purely by theoretical considerations, based upon the chemistry of glycerine and of diethylene glycol. Among the possible combustion products of glycerine, which is a three-carbon trihydroxy alcohol, is acrolein, an exceedingly irritating and toxic aldehyde. Diethylene glycol, on the other hand, being made up of two molecules of ethylene glycol from which one molecule of water has been removed, has only a two-carbon chain. For that reason it was thought that it would not produce any

Empirical methods of the old-time manufacturers of cigarettes have been replaced in modern factories by the most careful and painstaking chemical and engineering control

acrolein and therefore would not add to the irritant properties of smoke.

To test these theoretical considerations, an extensive research was initiated to compare smoke from cigarettes in which glycerine and diethylene glycol respectively had been used as the hygroscopic agents. Making use of a smoking machine which exactly duplicated normal smoking conditions, water solutions of the water-soluble constituents of the smoke were prepared and put into rabbits' eyes. It was found that the resulting edema, which was a measure of the irritant properties of the smoke, was much less severe, and lasted a much shorter time, in the case of the diethylene-glycol-treated cigarettes. Furthermore, all of the several brands of cigarette made with glycerine that were tested gave identical results, regardless of the method of manufacture employed.

Following these results, tests were conducted by a group of doctors, most of whom were nose and throat specialists, who supplied a considerable number of patients first with diethylene-glycol-treated cigarettes and then with cigarettes made with glycerine. Each subject was selected because he suffered from some form of congestion brought on by excess smoking. Each was examined periodically until some improvement was noted, when he was given a fresh supply of cigarettes which differed from the first only in being made with glycerine. The fact that a change had been made was not disclosed to the patients.

Results were conclusive. On smoking the diethylene-glycol-treated cigarettes, congestion in the majority of cases cleared up completely—and in the rest beneficial effects were noted. On returning to the glycerine-treated cigarettes more than three-fourths of the subjects reverted to their original condition.*

Since the successful conclusion of these demonstrations, only diethylene glycol has been used as the hygroscopic agent in Philip Morris cigarettes. The first stage in manufacture, therefore, consists in the addition of a suitable quantity of this material, together with enough water to bring the strips into good cutting "order." The conveyor from the stemmery discharges into a large inclined drum, rotating slowly, which tumbles the tobacco through a mist of the "casing" solution. Application of the solution is checked by flowmeters and controlled by regulators. A series of high-pressure nozzles gives effective atomization. The tobacco as cased may be heated in the same cylinder, to increase the rate of absorption of the pre-cutting solution, and may receive further heating (to about 110 deg. F.) before cutting. To cut cigarette filler into long shreds without breakage, the tobacco must be very pliable; and a higher temperature as well as a higher percentage of moisture makes it softer.

Burley tobacco is a chocolate-colored, thin, papery and very porous type, which in comparison with the more hygroscopic flue-cured and Turkish is quite deficient in carbohydrates. It frequently receives an entirely different treatment. This tobacco is actually dipped into a heavy syrup of sugar, licorice, some hygroscopic substance, chocolate, etc., passed through a wringer to remove the excess solution and dried at about 110 deg. C. In some cases, particularly for pipe and chewing tobaccos the Burley may gain as much as 50 per cent by weight. The addition of a considerable quantity of sugar to this tobacco deficient in that substance and the removal of a large part of the nicotine by solution in the water alter the flavor and texture of the tobacco considerably. The dipping is accomplished by forcing the Burley strips through a trough containing the liquid, after which the dipped tobacco is carried to the wringer by long teeth on a conveyor belt. As discharged from the wringer, the strips are spread automatically on the wide, slowly moving apron of a long tunnel dryer. In some cases the tobacco is held down by another wire apron close above it. Automatic temperature and draft control assure a uniform product. A small proportion of this dipped Burley is added to blended cigarettes ahead of the cutting machines.

A cutting machine of the latest type consists of a pair of converging belts which force the tobacco, as a fairly tight plug, through a hardened steel throat, the end of which is ground perfectly flat. A series of knives on a rotating arbor, fastened like the blades of a fan, shave off the plug of tobacco in thin flakes. The knives are continuously ground sharp and automatically fed up as they wear down. Until recently, most cutting machines used reciprocating knives very similar to a guillotine, heavy steel blades which had to be removed and sharpened every 10 to 15 minutes.

As cut, the fibers of tobacco are tightly matted in flakes containing 16–19 per cent water. With a higher temperature the tobacco may be cut with less moisture; at room temperature, a higher moisture is needed. Several cutters discharge to a common conveyor belt into a steam drum dryer where the tobacco is brought down below 12 per cent water and loosened into a light, fluffy mass. The dryers for cut cigarette filler are heated by steam pipes (as many as 72 1½-in. pipes in a 4-ft. drum) running the length of the dryer, over which the shreds of tobacco are tumbled as the dryer revolves. The steam discharged from the dryer goes through an air heater below the dryer itself, by means of which the entering air is raised to about 100 deg. C. With a constant feed of tobacco to the dryers, a dry-bulb control in the dryer varying the steam pressure, and a wet-bulb control in the exhaust air duct varying the air supply, it is possible to deliver tobacco of practically uniform moisture content.

As a result of the addition of 3 to 4 per cent of diethylene glycol, the cigarette filler at 12 per cent may be handled without excessive breakage, being about as pliable as untreated leaf at 15 per cent. But it is not nearly so likely to mold. The dryers discharge into pneumatic conveyors which carry the tobacco to coolers, revolving drums in which a countercurrent of cool air brings it down to room temperature.

As a check on the whole operation, the tobacco is continually sampled at the coolers and its percentage of water determined by an electrical conductivity method of remarkable speed and accuracy. From the coolers on, all operations are conducted in an atmosphere of such humidity that the tobacco will just hold its moisture of about 12 per cent. Every process is controlled to deliver the most uniform possible product to the cigarette machines.

When a number of drying and cutting units are producing the same kind of cigarette filler it is usual prac-

*These tests were completely reported by:
Mulinos and Osborne, Proc. Soc. Exper. Biol. and Med., 32, 241-5, 1934.
Mulinos and Osborne, N. Y. State Jour. Med., 35, 590, 1935.
Frederick B. Flynn, *Laryngoscope*, 45, 149-54.

tice to blend the output and discharge it all from a common conveyor. The prepared filler is generally stored in small fiber or wooden boxes which hold about 100 lb. apiece. These can be stacked five to six high, utilizing the full height of the storage room without having any very deep layer of tobacco. It is necessary that the tobacco as delivered to the cigarette machines be light and fluffy and this purpose is better accomplished by storage in the small boxes.

After a two- to four-day storage period, which permits the volatile flavor to permeate the tobacco, it is delivered to the cigarette machines. All such machines consist of a hopper from which tobacco is raked by carding drums and delivered in a fine uniform stream to the paper. In more modern machines an auxiliary hopper may be provided to deliver definite quantities of tobacco to the feeding hopper. Usually there is an arrangement of rakes and tampers to keep a constant quantity on the feeding drums. The weight of the cigarette is very sensitive to the pressure of tobacco on the feeding drums and, the more nearly constant this can be maintained, the more uniform the cigarettes. These drums are raked clean by toothed rollers ("picker rollers") and the shreds dump into a long U-shaped hopper over the paper. The paper has previously been printed with the brand mark; running along at 350 ft. per minute it picks up the proper quantity of tobacco in about 4 ft. The edges are then curled up, paste is applied, the edge is folded down and sealed by an electric heater, and the "rod," one long cigarette, is cut off every 70 mm. Incidentally, close control of the quality of the paper and the viscosity and surface tension of the pastes used is essential, for slight variations can tie up an entire plant. The cutting knife must have a double reciprocating motion, for to insure a clean cut it should travel in the same direction and at the same speed as the cigarette. The cut-off delivers the cigarettes at the rate of 1,200 to 1,500 a minute to a belt or belts moving at right angles to the motion of the rod. On the belts the cigarettes are inspected and placed in trays with removable bottoms and the trays sent by conveyor or push-truck to the packing machines.

For every five to seven cigarette-making machines there is another inspector who goes from one machine to the other, sampling and weighing its production. The weights are usually recorded as the number of cigarettes per ounce and if this factor changes appreciably the inspector instructs the operator to correct the error. One new type of machine now being used has an automatic scale by which 50 cigarettes are counted out every minute. These cigarettes are weighed on an accurate balance and if the weight varies at all from a predetermined value the machine is adjusted automatically so as to bring the weight back to the desired value. In several factories it has been the practice for some time to weigh individually a certain proportion of the output from various cigarette machines. The statistical distribution of the individual weights is one of the best possible checks that can be made on the performance of the cigarette machine.

There are now available automatic scales which count out the cigarettes, weigh them accurately one at a time, and automatically record the results. With such a scale about 150,000 individual cigarettes are being weighed each month in the Philip Morris plant.

The trays of cigarettes are placed on racks above the packers, and on sliding out the bottom of a tray, its cigarettes fall into the feeding hopper. Automatically, 20 cigarettes at a time are counted out, both ends of each cigarette are inspected by electric feelers, and the 20 are pushed into the pack which has been formed in another part of the machine. These machines perform all the operations of cutting the foil from a roll and folding it into the familiar cup, counting, inspecting, and inserting the cigarettes, pasting and folding the label, ejecting packs with imperfect cigarettes, and closing and stamping the pack, in perfect synchronism at 120 packs per minute with only one attendant.

The output is inspected and delivered to a Cellophane wrapper, which may wrap as many as 240 packs per minute. The pack is pushed into the middle of a sheet of Cellophane, the edges of the sheet are wet by a glycol ether which dissolves the coating, the sides are folded down and the solvent is evaporated under electric heaters. The resulting seal is almost gas-tight and as a result of the wrapping, the moisture gain or loss has been cut to a fourth the rate with an unwrapped pack. The completed packs are put in cartons, carried on belt conveyors to carton wrappers, and then packed into fiber-board containers holding 10,000 cigarettes. The finished product is stored on lift trucks and finally sent down a roller conveyor to the shipping platform.

As should be inferred from the foregoing, the whole manufacturing process is subject to painstaking chemical and engineering supervision, from the continual checking of moisture content and the operation of the several air conditioning plants, through the control and analysis of pastes and other materials, to the design and installation of equipment peculiar to the tobacco industry. In its transition from art to science, cigarette manufacture has offered many interesting research and engineering opportunities. Continuing developments may be expected to yield further improvement in processes and products.

Cigarette machines in operation at Philip Morris plant

Selecting

Most Suitable Drum for Your

By R. W. LAHEY
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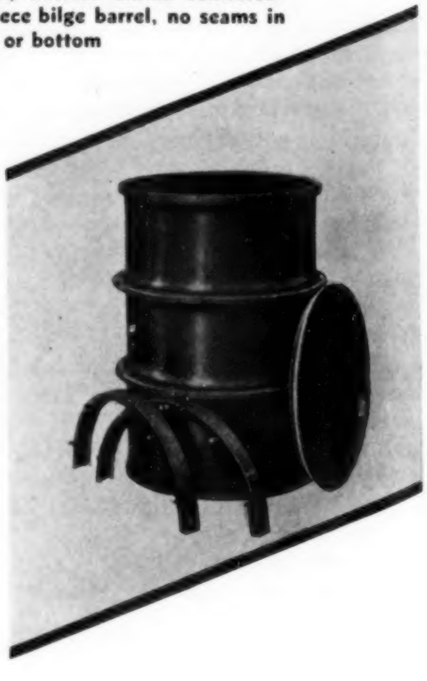
New York, N. Y.

Editor's Note: At the Sixth Packaging Exposition held in New York, March 3-6, the award sponsored by the American Management Association for packaging construction was voted to the Aero carboy (see Chem. & Met., November, 1935, page 625) entered and used by American Cyanamid Co. and designed by R. W. Lahey and K. N. Sieg.

IN THE ARTICLE on returnable drums for chemicals in a recent issue of *Chem. & Met.* (Vol. 43, p. 28, January, 1936), the returnable drum was compared with the surrounded army which is attacked from the front, the rear, both sides and from within. The army of today is composed of units particularly trained for their respective jobs. For instance, in the infantry there are machine gunners, bomb throwers, signal men, runners and other specially trained men. Likewise, in the field of returnable drums, we have not only drums especially designed to carry acids, inflammable liquids, alkalis, and other materials, but there are rubber-lined drums for hydrochloric acid, chrome-nickel and aluminum drums for nitric acid, and steel drums for sulphuric acid and hydrofluoric acid. At the risk of possible ridicule it is therefore necessary to use the much maligned term "specialist" when referring to returnable steel drums. Each type is especially designed to cope with the chemical and physical characteristics of the product carried. In the adoption of these specifications consideration has been given to the safety and convenience of the men who fill, handle, empty and clean these containers. Drums have therefore been designed to meet the requirements of each product shipped in them, and they must be considered specialists in their particular field.

The first step in choosing a drum is to determine whether the product is dangerous as defined by the Interstate Commerce Commission Regulations for the Transportation of Explosives and Other Dangerous Articles. Most shippers are familiar with these regulations, but if not, please refer to the article on this subject (*Chem. & Met.*, Vol. 42, pp. 267-71, May, 1935). If the material is dangerous, the regulations will give minimum container specifications which are authorized by law for shipment and this will considerably simplify the problem, except as to certain construction details. If the material is not dangerous, it must then meet the minimum specifications laid down by the railroads, known as Section 5 of Rule 40 Consolidated Freight Classification Committee. The accompanying table gives the details of this ruling.

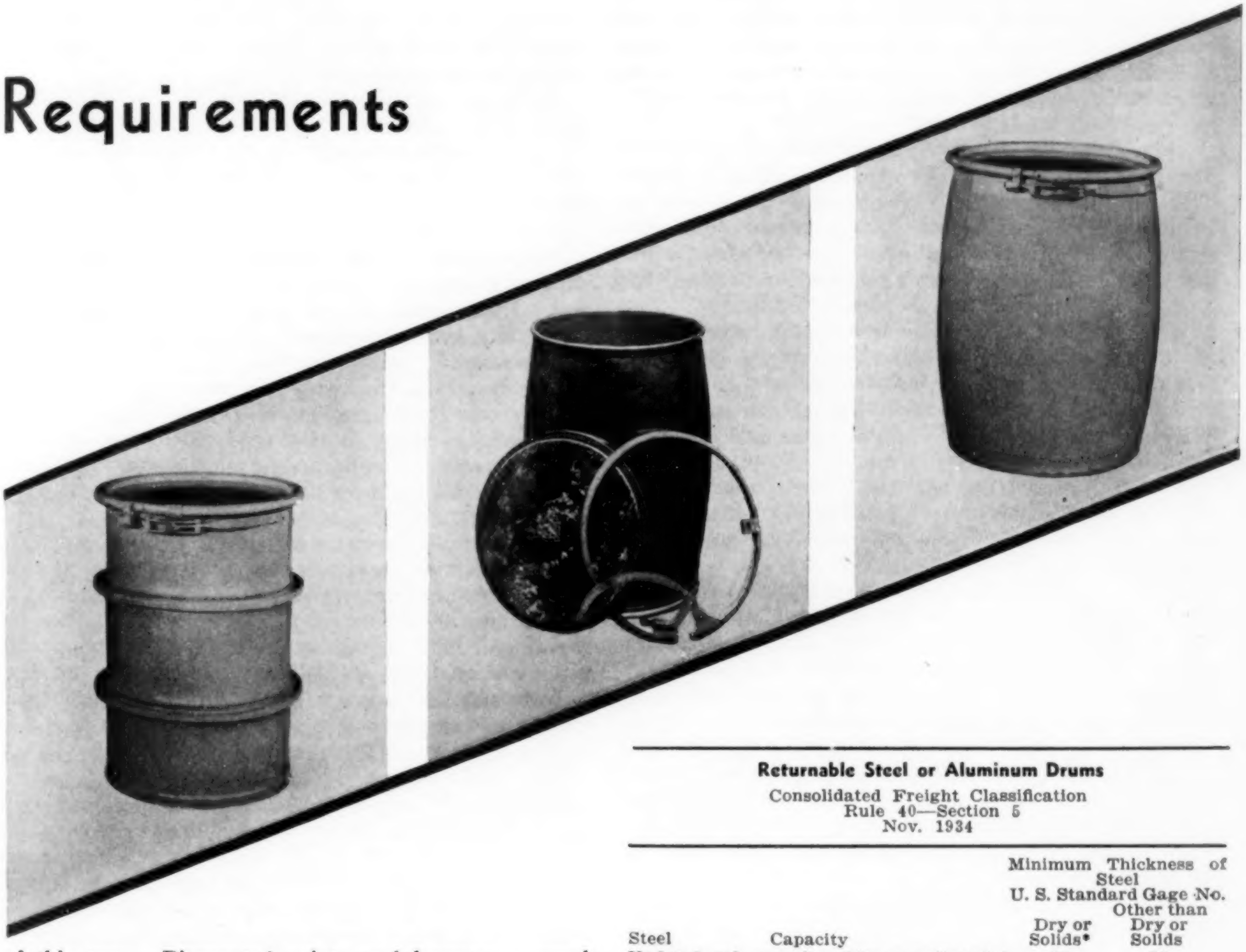
Full open-head drums were developed to carry solid or semi-solid products. Illustrations of: (1) straight side drum, welded side and bottom seams; (2) straight side drums, welded side seam, brazed or welded bottom seam, with or without bottom chime reinforcement; (3) bilge barrel, welded side and bottom seam, bottom chime reinforcement; and (4) one-piece bilge barrel, no seams in side or bottom



With the question of regulations settled, the next step is to decide on the details of construction of the drum to meet the particular needs of the product. How effectively these have been worked out can best be illustrated by describing some of the most important types of drums in service.

Full open-head drums were developed to carry products of a solid or semi-solid nature, such as pastes, nitrocellulose cotton wet with water or alcohol, and so forth. This construction facilitates the loading and emptying of their contents. Food products such as animal and vegetable shortening, sugar compounds, and others, demand perfect cleaning, which is only obtainable in drums

Requirements



of this type. Pigmented paints and lacquers, enamels and other materials which require agitation before using are packed in drums fitted with agitators.

The open-head construction is manufactured in the bilged and straight-sided types. Heads are the same for either type. Attached sketches show the more important designs and the methods of closure employed. Pressure is applied on a gasket between the cover and the chime of the drum by means of reduction in the diameter of a crescent-shaped locking ring. Another method is to attach two half-circle "C" hoops over the flange of the head and the flange of the barrel. They are locked in place with an ordinary screw driver by several case-hardened set screws. These closures will hold up to 15 lb. of air pressure or up to 40 lb. of hydrostatic pressure depending on the gasket. Cork, asbestos, leather, felt, cotton and rubber gaskets are used, depending on the type of product packed. The mouth of the drum is curled outward to provide a smooth surface for emptying and cleaning. Sometimes ¾ to 2-in. openings are placed in the sides or bottom of the drums to reduce the time required to empty heavy pastes and semi-liquids.

There are two types of bilged barrels on the market. One is a cold-drawn seamless drum and the other has a butt-welded body seam with the bottom either welded or brazed to the body. One type has a reinforcing ring

Returnable Steel or Aluminum Drums

Consolidated Freight Classification
Rule 40—Section 5
Nov. 1934

Steel Capacity	Minimum Thickness of Steel U. S. Standard Gage No. Dry or Solids*	Minimum Thickness of Steel U. S. Standard Gage No. Other than Dry or Solids
Under 5 gal. capacity (kits or pails only)	28	26
Under 5 gal. to and including 7 gal.	26	24
Over 7 gal. to and including 10 gal.	26	22
Over 10 gal. to and including 20 gal.	24	20
Over 20 gal. to and including 35 gal.	23	19
Over 35 gal. to and including 58 gal.	22	18
Over 58 gal. to and including 75 gal.	20	16
Over 75 gal. to and including 110 gal.	20	14
Over 110 gal. but not exceeding 165 gal.	18	12

Aluminum with Metal Rolling Hoops or with Steel Jackets	Minimum Thickness of Aluminum U. S. Standard Gage No. Sides & Ends
5 gal. to and including 10 gal.	18
Over 10 gal. to and including 35 gal.	16
Over 35 gal. to and including 55 gal.	13
Over 55 gal. to and including 110 gal.	11

The caps, covers, plugs or tops must be securely fastened, and filled packages must be proof against leakage or sifting.

All steel shipping barrels or drums other than single trip containers manufactured after July 1, 1926 and all aluminum shipping barrels or drums manufactured after Mar. 1, 1930, for use as freight containers, must bear the manufacturers name or an identifying symbol or trade-mark, which must be registered with the Consolidated Classification Committee, the U. S. standard gage of metal in its thinnest part, capacity of container, and year of manufacture—these may be abbreviated and then must appear in order specified, for example, 18-55-20 which will signify that the container is made of 18 gage metal, is 55 gal. capacity, and made in the year 1920. The inscription must be embossed or stamped on the container or on a plate securely brazed, welded, or soldered thereto in letters that are legible and not less than ¼ inch in height. These requirements will not be necessary for steel shipping barrels or drums other than single trip containers when manufactured in foreign countries, but shipping orders and bills of lading must bear the following certificate.

"The steel shipping barrels or drums used for this shipment are of foreign manufacture and conform to construction requirements of Rule 40, Section 5."

* The term dry or solid is defined as referring only to articles which are dry or solid at a temperature of 100 deg. F.

covering the bottom weld. The bottom crevices on the inside of these drums are closed by fillet welding. This latter type can be made of lighter metal than the one piece cold drawn type, as there are limits to the machinery which is available for drawing steel. Advantages of the seamless type are of course added strength and an inner surface which is entirely smooth without crevices to complicate cleaning.

There are a variety of straight-sided, full-open-head drums on the market. They have welded body seams with bottoms attached by double seaming, brazing or welding with the addition of chime reinforcements. The straight-sided type have rolling hoops for ease in handling. These hoops are either swedged or of the I-bar type. The swedged hoops do not increase the tare weight, but they have the disadvantage of more difficult cleaning, due to the inner depression of the hoop, and they do not provide the added strength to the container that is obtained with the I-bar. The increase in the tare weight for the I-bar is 14 lb. for the $\frac{3}{4}$-in. and 17 lb. for the 1-in. hoops on a 55-gal. drum.

It is obvious that the purchase price is not the only factor in the selection of open-head drums, but length of service and upkeep costs in the form of cleaning and repairs must be taken into account.

Tight or liquid drums are made in a variety of types, metals and fittings, some of which are described below. The so-called acid drums, if not the most important in quantity used, certainly is in the first rank from the standpoint of safety. These drums are listed according to I.C.C. specification numbers as follows:

I.C.C.—5A. Steel—for sulphuric acid 66 deg. Be. and stronger, mixed nitric and sulphuric acid, hydrofluoric acid 60 per cent and stronger, and other corrosive liquids that do not readily attack steel.

I.C.C.—5C. Chrome-nickel steel—for nitric acid 80 per cent and weaker.

I.C.C.—5G. Chrome-nickel steel—for certain inflammable liquids.

I.C.C.—5D. Steel rubber-lined—for muriatic acid.

I.C.C.—5H. Steel with lead bonding—for sulphuric acid not over 92 per cent, hydrofluoric acid, bromine and certain corrosive chlorides.

I.C.C.—42B. Aluminum—for nitric acid 80 per cent and weaker.

I.C.C.—42C. Aluminum — for certain inflammable liquids.

I.C.C.—42D. Aluminum—for hydrogen peroxide with content of 5 per cent H_2O_2 and stronger.

Acid drums are safe and adequate shipping containers when properly handled by experienced individuals. If certain precautions are not observed there is danger from possible explosions, bursting, and leakage which may result in property damage and personal injury and perhaps loss of life. The Steel Drums Committee of the Manufacturing Chemists Association has issued bulletins which summarize all instructions for handling, filling, emptying, storing, and repairing these drums. There are separate manuals for shippers and consignees. These may be obtained from the Washington office of the M.C.A. for a small sum. No shipper or handler of acid drums can afford to be without this information.

These drums must stand many types of abuse by the customer, the foremost of which are the following:

1. Failure to vent drum at frequent intervals builds up excessive internal pressure in hot weather. This often causes the drum heads to bulge, thereby distorting the double-seamed joint between the head and the shell which is a vulnerable point. This may also occur when drums are filled without leaving sufficient outage for expansion and vaporization.

2. Failure to make openings air tight after emptying causes the undrained residue to absorb moisture from the air, weakening the acid. In the case of sulphuric, this weak acid will actively attack the steel and often ruin the drum.

3. Use of air pressure for discharging is dangerous.

It is evident that the container which transports these dangerous corrosive liquids must be of the best materials and workmanship. These drums are obtainable in the three-piece construction with heads attached by either double seaming or welding both of which have chime reinforcements. The two-piece construction, consisting of two cold-drawn cups welded circumferentially adjacent to the center, is also used extensively in transporting corrosive liquids. Although the two-piece drums cost more than the three piece, they have no head seams and they last longer in sulphuric acid service. Some of the shippers who have tested both types believe that the cost per trip of the two-piece construction is cheaper while others disagree. Both types should be tested in actual shipping service on a comparative basis and the results will indicate the best practice to be followed in each individual case. Conditions are so different as to type of shipment, storage and care of drums by both shipper and customer that no general rule can be safely applied.

The I.C.C. regulations for the 55-gal. size require a minimum of 14 gage metal but some shippers prefer 12 gage. The 12 gage drums weigh approximately 125 lb. as compared with 105 lb. for the 14 gage. Here again each shipper must be guided by his particular conditions.

Special attention must be given to the quality of the welding as a defect of this type invites rapid corrosive action by the acid. This is of particular importance at the bung weld as the acid is apt to attack at this point. Spuds and bungs fabricated from forgings quality steel usually give better service and last longer than fittings made from bar stock.

Drums should be repaired only by workmen thoroughly experienced in this type of work with full knowledge of the hazards encountered. Before work is started on any acid drums they should be prepared for the mending process as recommended in the M.C.A. manual previously referred to. Some of the more common failures which can be repaired by the shipper are:

1. Corrosion at the bung which is caused by electrolysis. Old spuds can be cut out and replaced by welding in new spuds thereby increasing the life of the drums by from 30 to 40 per cent.

2. Broken or displaced rolling hoops can be rewelded and replaced or new hoops may be attached.

3. Bulged heads and dents may be removed by the process suggested in a previous article on this subject (*Chem. & Met.*, vol. 43, p. 28, January, 1936).

In addition to acids these I.C.C. 5A drums are used to carry corrosive alkalis such as liquid caustic potash and liquid caustic soda solutions. Although the regulations permit the use of the I.C.C. 5 drums for shipments of

these corrosive alkalis, some shippers use the I.C.C. 5A drums to obtain increased safety and longer life of the 5A drums. Alkaline liquids do not generally attack steel and usually do not develop excessive internal pressure. The principal container problem is therefore one of providing sufficient strength to resist transportation abuses.

Included in this general classification of acid containers are drums made of aluminum, chrome-nickel steel, and steel with rubber linings. The same general methods of construction are used to fabricate these drums with the exception of those with the rubber lining. The same general precautions should be observed in the handling, filling, emptying and repairing of these containers.

Although it is not mandatory to ship inflammable liquids flashing above 20 deg. F. (by the open cup Tagliabue tester) in returnable drums there are many of these containers in this service. In addition, all inflammable liquids flashing below 20 deg. must be shipped in returnable drums. (Request has been made for permission to ship liquids flashing from 0 deg. F. to 20 deg. F. in 16 gage one-time shippers to be known as I.C.C. drum specification 5J. This subject was discussed at the Bureau of Explosives' hearing on Jan. 28, 1936.) Included in both of these classifications are many products, some of which are solvents, lacquers, alcohol, thinners, paints, varnishes and many other non-corrosive liquids.

The minimum thickness of returnable drums for inflammable liquids as defined in the I.C.C. regulations is specified as 14 gage for the 110-gal. and 16 gage for the 55-gal. size. It is evident that these drums do not need the extra metal protection required for acids as they are not attacked by their contents. This results in a safe and welcome reduction in the tare weight. The important consideration in the choice of drums for this group of liquids are: (1) Sufficient structural strength to resist both the abuses of transportation and the internal pressure developed by the liquids under high temperatures; and (2) Ease of cleaning.

In reference to the first consideration, the drum should be chosen for its ruggedness and minimum weight. Heads should be so attached to the shells and so shaped as to resist internal pressure. A recent series of tests on 18-gage single trip drums with flat and convex heads, conducted by Douglas G. Stewart (E. I. duPont de Nemours & Co.) for the Steel Drums and Barrels Committee of the M.C.A., proved conclusively that convex or crowned heads were much stronger in drop tests, and resisted hydrostatic and internal air pressure better than flat heads. Results on 18-gage drums can be safely applied to drums fabricated of heavier metal. The investigation showed that a convexity of from $\frac{3}{4}$ to $1\frac{1}{4}$ in. gave the best results.

The problem of cleaning cannot be overlooked. Solvents, lacquers and paints must be entirely free from dirt or other contamination, otherwise shipments may be rejected and sometimes customers lost. Unfortunately, expenses of this type as well as cleaning costs are not always considered when purchasing drums. It is therefore to the best interests of the management to provide every convenience for perfect cleaning.

A somewhat different condition is encountered by drums in the 26 deg. Be. aqua ammonia service. The action of the ammonia on the steel, although not corrosive, discolors the product. The usual means of overcoming this difficulty is to store the drums filled with ammonia (called pickling or pacifying) until no residue results. This treatment may take several months, during which time drums are emptied and refilled at 30-day intervals. Once a drum is properly pickled it will satisfactorily transport the aqua ammonia as long as no untreated steel comes in contact with the contents.

A few years ago one manufacturer developed a process to treat the steel which is comparable with pickling, thus eliminating the necessity for treating the drums. This has proved to be a real benefit.

There is no corrosive action of the ammonia on the drum, and the internal pressure which is developed in summer temperatures is not excessive. They should be vented at intervals and before removing the plug regular venting precautions should be observed.

The three types of drums just described were picked because they have special conditions to contend with which must be provided for in the construction of the containers. They are outstanding examples of the fact that returnable drums are custom made to fit the peculiarities of the product. There are many other products which travel to market in returnable drums, but the majority of these substances do not require their containers to surmount hardships similar to those just cited.

Every seller of dangerous articles is morally and legally obligated to caution his customers as to the dangers involved in the handling and use of the materials sold. In addition, education of the consignee in the proper handling and care of drums will unquestionably pay dividends in the form of added life of the containers. This can be accomplished by sending them printed instructions such as the consignees' manuals published by the Manufacturing Chemists' Association and by attaching warning labels to the drums.

Many items of expense, such as return of contaminated material, damage claims and loss through leakage, which can be allocated to defective or unsatisfactory drums should be added to the container cost. If this is done it will be found that the initial cost is in most instances not the most important consideration. The many shippers whose purchases are influenced by the first cost of the drums do not more than scratch the surface of the problem and if substantial quantities of drums are used, desirable operating savings are lost sight of to obtain what is considered a purchase bargain.

Warning label for dangerous products

From Manual Sheet D-38 of Manufacturing Chemists' Association, Drums, Steel (Returnable and Non-Returnable)—Warning Labels, (For Drums Containing Inflammable Volatile Liquids), Standard adopted 1936


CONTENTS INFLAMMABLE

TRANSPORTATION COMPANIES:

KEEP BUNGS TIGHTLY CLOSED

KEEP DRUM OUT OF SUN AND AWAY FROM HEAT

CONSIGNEE:

KEEP BUNGS TIGHTLY CLOSED

KEEP DRUM OUT OF SUN AND AWAY FROM HEAT

DO NOT EMPTY THIS DRUM BY PRESSURE

REPLACE BUNGS AS SOON AS DRUM IS EMPTY

Drum Should Not Be Washed Out Or Contaminated With Other Materials

KEEP NAKED LIGHTS AND FIRE AWAY FROM DRUM

THIS DRUM IS RETURNABLE

M.C.A. OF U.S. FORM D-38 PRINTED IN U.S.A.

Nickel Alloys for Low and High Temperature Service

By BYRON B. MORTON
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IN A REFINERY in which a complete line of petroleum products is prepared, metal temperatures will be encountered that range from —70 deg. F., and lower to about 2,000 deg. F. Over this entire range, nickel is an important alloying element, and at the lower and upper ends of the range it is practically indispensable.

Low-Temperature Range

Within the range, below 32 deg. F., in which dewaxing of lubricating oils is carried out, the impact value of most steels decreases to a marked extent. Steels containing 3 to 5 per cent of nickel retain a good portion of their room temperature impact resistance at sub-zero temperatures. Alloys rendered austenitic by additions of nickel to an iron base retain excellent impact values down to the temperature of boiling liquid air and the austenitic chrome-nickel alloys of the 18-8 type also retain excellent values down to —100 deg. F.

Among nickel nonferrous alloys Monel metal has outstanding qualifications for low-temperature uses. The alloy loses none of its impact value down to —297 deg. F., while the strength and yield point increase in value at sub-zero temperatures over the values obtained at room temperature. The endurance limits of Monel also increases at sub-zero temperatures.

The 2¼ per cent nickel steels with low-carbon contents have been adopted and widely used for fabrication of large vessels used in connection with dewaxing of lubricating oils. Some of the vessels fabricated of this alloy steel exceed 11 ft. in diameter. Certain considerations that led to their use for large welded vessels for low-temperature service are: ease of fabrication, satisfactory weldability and high impact values in both plate and weld at low temperatures (—50 deg. F.) following a simple stress relieving heat treatment of 1,150 deg., such as called for in the pressure vessel codes. The 2¼ to 3 per cent nickel steels are also used for piping, pipe fittings and attachments to vessels, as a result of their high impact values at low temperatures. Parts made of low carbon (0.10 per cent C.) cast nickel steels retain good impact values to 114 deg. F. These cast nickel steels find use in valve bodies and fittings; also in pump parts.

Monel is used as centrifuge bowls for operating at low temperatures in the removal of wax from oils. These bowls are subject to high tangential stresses and to the impact and reversal of thermal stresses that occur when cold—and sometimes hot—charging stocks are introduced. The high yield point of Monel makes it of particular value as a material for centrifuge bowls.

That the low-temperature service of metals will increase in scope is indicated by the researches under way upon the effects of low temperatures in modifying certain reactions and in increasing the selective action of solvents. The austenitic steels and Monel will probably come into increased use where very low temperatures of metal are encountered.

Medium-Temperature Range

It is within the range of metal temperatures from 32 to 1,400 deg. F. that the bulk of alloys find their use in refineries. Corrosion is an important factor in the selection of alloys for vital parts of equipment used within this range. Where the metal temperature is sufficiently low, condensation of moisture and acids occurs and attack from electrolytic corrosion is important. Above a temperature that permits condensation, vigorous attack from sulphur gases is an important factor.

Ni-Resist, one of the most generally used nickel alloys employed in refineries, finds wide application within the temperature limits that permit acids and moisture to exist. The alloy is used to line pumps that will handle crudes, reflux material, sludge acid, caustic, corrosive waters, and a number of other materials. Valve parts for pumps handling corrosive substances are also made of this alloy. It is used as a trim for gate valves, and is particularly used as a trim where the water accompanying crudes is of an acid nature.

Refluxes are often corrosive and are especially so when the material refluxed is directly from a crude containing salts that break down to form hydrochloric acid. In this case the reflux attacks pumps, lines and parts of the towers. Ni-Resist bubble caps and trays are used where rapid corrosion from acids is a factor. The pumps handling the corrosive reflux material are often of Ni-Resist, and in a number of cases the lines conveying the reflux back to the tower are of this alloy. The use of cast iron within "battery limits" is a matter of policy and regulates the use of Ni-Resist lines. The towers are often protected by cement linings from acid attack but where cement cannot be applied thin-gage Monel sheet is used. Protection in this manner can be given heads, manholes and nozzles.

The high-nickel alloys as Monel and Ni-Resist, are

Based on an article, Use of Nickel-Bearing Alloys in Oil Refineries, in *Oil & Gas Journal*, May, 1935.

attacked by sulphur gases at high temperatures. They find their chief use where, due to the presence of moisture, the sulphur compounds act as acids. For example, Monel resists the action of corrosive sulphur compounds in refinery gases and is widely used as orifice plates and valve trim in this service. Headers and sheets of Ni-Resist are used in coolers handling refinery gases which are compressed prior to going to absorption units which recover the gasoline and light fractions from these gases. This is a location of severe corrosion. Where sulphur vapors at temperatures above 300, are encountered, the 18-8 alloys are widely and effectively used. The use of these alloys covers: coil tubes, bubble caps especially for the bottom of the towers, liners, pump rods, and a host of other applications.

Hot oil pumps often offer problems in selection of material for plungers or rods. Alloys containing approximately 20 to 22 nickel, 8 to 10 chromium, 0 to 1.0 copper, 0 to 1.0 silicon, and about 0.15 per cent carbon, are used in some cases. These alloys have the widest application for pump rods and plungers of any alloy type encountered. They are used for hot oil pumps, pumps handling cold acids and bases—including ammonia—reflux materials, brines, water and oils, and are apparently quite satisfactory for all these varied uses. An interesting method of getting around plunger-scoring has been adopted by some refiners. The original plunger is turned down and a sleeve of a chrome-nickel-molybdenum alloy cast iron which has been hardened to 500-600 Brinell is placed on it. Where abrasion is an important factor, liners are used of alloyed cast irons which have been heat treated, or the pumps are made of Ni-Hard.

Sulphuric Acid Corrosion

Where corrosive conditions such as encountered in handling sulphuric acid and reflux materials require the use of pump rods of Monel, the use of K-Monel is indicated, since this material can be hardened to 300-375 Brinell.

Some of the most efficient exchangers known have tubes of 18-8 alloy. However, there have been a number of cases of failure of 18-8 bundles. The failures were due to two causes, the first of which is poor design that did not allow the tubes to freely expand resulting in fatigue failures and rupture in tension. The second cause of failure is attack by reducing acids. The high-chromium alloys by virtue of building up a dense film of oxides or sulphides are quite resistant to oxidizing acids and sulphur gases at high temperature but these alloys are poorly resistant to reducing acids, as sulphuric and hydrochloric acids. Sometimes an oxidizing agent is added to sulphuric acid and 18-8 alloys can be used with complete satisfaction.

Correction of the causes of 18-8 tube failure listed above lies in the first case with designers. The second case can be corrected by introducing ammonia into the system prior to a shutdown or at any time that condensation can occur. The nickel-bearing nonferrous alloys—as the 80 copper-20 nickel; the 70 copper and 30 nickel alloys, and others—are gaining widespread acceptance in refineries for use in condensers and coolers. The 70-30 is used where sea water is the cooling agent, since it is highly resistant to this material and especially resists pitting which is the cause of much destruction of Admiralty tubing in sea water service. Tubes of pure nickel, Monel, and of 18-8 plus molybdenum, are appearing more in refineries as the technologists turn their attention to byproducts.

Nickel alloys find their use around fired coils in the form of parts of header boxes, valves and fittings and also as tubing where 18-8 tubes are used. The 18-8 tubes have been rightly described as the aristocrat of tubes, since they give excellent performance, but vent a "lordly wrath" when abused. It has become recognized that the temperature of tube walls should not be allowed to exceed 1,200-1,300 deg. F. Results of this requirement is that a special feed for coils of 18-8 tubes is necessary. This feed must be clean and refractory, and when these conditions are met the coils equipped with 18-8 tubes are excellent gasoline producers. Where 18-8 tubes are used to convey hot oils to and from various parts of units the rate of inspections is materially reduced due to low corrosion rates and "turn-around" time is shortened.

A number of chlorinated solvents break down somewhat when heated in the presence of steam during the recovery operation. The metal of the vessel used in distilling plays an important part in the breakdown. In addition to causing breakdown of solvent at a slower rate than does steel, nickel and Monel are both quite resistant to the hydrochloric acid formed, which is not the case with steel; hence parts of distilling equipment used to recover these solvents will probably show wider use of these metals than is now the case. Monel is now used as orifice plates, thermocouple wells and trims.

In treating of oils with acids the time of contact is considered important and is controlled in a well-known process by using high-speed centrifuges to remove the acid. The bowls used are of Monel metal. Similar bowls are used to remove finely dispersed acid sludge from lubricating oils.

Where a separation of acid and sludge from heated oils is done by gravity, the problem of a valve is often of importance, especially if the temperature of the material handled is 180-200 deg. F. Monel valves trimmed with an alloy containing 50 per cent or more of nickel, 2-20 per cent molybdenum, also chromium and tungsten, is found to be satisfactory. This highly alloyed material makes good tips for burners where acid sludge is the fuel, though S-Monel and Ni-Resist cast iron are both used for this service. Pump valves in high pressure, high-temperature pumps are often of the 24-28 per cent chromium 12 per cent nickel type alloy.

A considerable amount of nickel alloys is used in the form of sprayed coatings. Pump rods are built up with 18-8 metal; pump impellers handling corrosive waters are sprayed with Monel; seats of valves are built up with 18-8 and Monel; vessel walls are sprayed with 18-8 when attack from hot sulphur compounds is taking place.

The atmosphere within storage tanks is often quite severely corrosive. Monel is used in tanks as the cable on swing pipes and parts of permanent gaging equipment. The usual portable gaging equipment is often made of Monel.

Supports for tubes in fired coils represent a large tonnage of heat-resistant alloys. The most generally used alloys are castings that contain 25-30 per cent

chromium with 10-14 per cent nickel. The latter acts to give strength to the casting.

Certain experiments carried out at the laboratory of the International Nickel Co. also throw some light on the subject of the effects of nickel on strengthening of heat resisting alloys. The test consisted in holding specimens at 1,800 deg. F., until temperatures were constant, then loading with 3,000 lb. per sq.in., and noting the rates of flow.

The subject of sulphur attack upon high-nickel alloys is one which is little understood. As far as resistance to sulphur attack is concerned, the experience of the writer is that chromium can protect an equal per cent of nickel and that destruction of an alloy with 25 chromium and 20 nickel will be no more rapid at 1,800 deg. F. than will be the destruction of a 25 per cent chromium alloy with no nickel. Both alloys will be destroyed if hydrogen sulphide is present and both be equally resistant to destruction if the sulphur is in an oxide form.

Attack of 1,800 deg. F. upon heat-resistant alloys will be rapid if hydrogen sulphide contacts the hot metal. The adjusting of the burners is therefore important since the atmosphere of the fire-box may show excess air due to secondary air, but attack may go on owing to hydrogen sulphide of the fuel striking the hot metal before combustion with secondary air occurs. The attacked metal often shows spots and "sores"; apparently a metal sulphide is first formed that burns later to an oxide.

Ni-Resist cast iron is used for the tube sheet castings where conditions are not severe enough to warrant a more heat-resistant alloy. This alloy cast iron is quite resistant to oxidation at temperatures up to about 1,500 deg. F., and does not tend to grow as does gray cast iron.

Tubes of welded sheets of heat-resistant material of the approximate composition of 20-26 chromium, 12-20 nickel, are used for certain reactions carried out at temperatures of 1,500-1,800. There is a growing interest, in refineries, in high-temperature synthesis of materials from refinery gases, and a more general application of welded tubing of chrome-nickel alloys is probable.

Cast Iron Plates Form Durable Plant Roofing

RESISTANCE to attack by chemical fumes, ease of erection, elimination of maintenance, and permanence are the principal advantages of a cast iron plate roofing. The idea of using cast iron for roofing is not new. The dome of the Capitol building in Washington was covered with this material in 1870 and has withstood the ravages of time for over 60 years without repair. And at Smithville, N. J., a factory, built in 1878, is roofed with cast iron plates upon which the plant records show no expense for maintenance. The Usicast roofing recently developed by the United States Pipe & Foundry Co. differs only from the roofing on the Capitol dome and at Smithville in that improvements have been made in rendering the application more simple.

Cast to Fit Any Requirements

This iron roof is made up of thin cast iron plates laid on and attached to the channel purlins. Although the plates can be cast in any length to fit the requirements of the particular roof, the standard dimensions are 24 in. x 52 in. The plates are only $\frac{3}{16}$ in. thick and are correspondingly light in weight, the standard plates weighing 78 lb. Tests indicate that one of these plates can carry a total uniformly distributed load of 4,000 lb. on a 4-ft. span with an average deflection of $\frac{3}{8}$ in. at the center of the span.

Assembly is accomplished by laying the required number of plates to make up one course along the eaves. The plates are prevented from slipping by a lug cast on the under surface of the plates, which rests against the roof purlins. A gap of about an inch is left between the plates. The cap plates are then placed over the joints and securing lugs pass through the gaps between the plates. As soon as the cap plates are located, they are fastened to the purlins by means of cadmium plate hook bolts and clamps. Another course of plates is then laid with the joints staggered and the cap plates are set in place, and so on. Special ridge plates and cap plates are furnished for the ridge, and it is interesting to note that all of the assembly is accomplished from the outside except for the securing of the last ridge plate. This minimizes the use of stagings and scaffolds which tends to reduce the costs of erection and increases safety to the workmen.

In one case the roof area, 130 ft. long x 25 ft. on the slope was covered with cast iron plates. Two men removed the old roof and erected the cast iron plates. The actual time required for erecting the new roofing was $4\frac{1}{2}$ hr. for 150 plates, or about 1.4 squares of roofing per man hour.

Although paint is not necessary to protect the cast iron plates, it is possible to cover the surface if required. At a plant in Harrison, N. J., the plates were painted red on the upper surface to correspond with the rest of the roof and were coated with aluminum paint on the underside to reflect light.

Where the plates lapped, a strip of plastic cement was placed between the plates to form a weather-tight joint. Although joint caulking is not necessary, it is expected that it will be specified by many engineers on industrial jobs.

Advantages

Among the many advantages of a cast iron roof, perhaps the most interesting to the chemical engineer is its resistance to attack by the many chemical fumes that are prevalent both within and without most chemical plants. It is common knowledge that the cast iron roofs form an excellent safeguard against the ravages of fire. It will withstand the high temperatures of a conflagration with a minimum injury to its structure. It successfully resists severe vibrations and shocks without cracking. Expansion and contraction difficulties are obviated.

Carbon black being packed in paper bags for distribution to the rubber, printing ink, paint, lacquer, enamel and other process industries

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CARBON BLACK For the Process Industries

THE CARBON black industry has attained considerable importance in the United States. It supplies the rubber industry throughout the world. It is an essential coloring pigment for printing ink, paint, lacquer, enamel, carbon paper, phonograph records, and concrete roads. A previous article on the subject (Carbon Black Gains by I. Drogin, *Chem. & Met. Eng.*, Vol. 43, No. 2, p. 95, February, 1936) briefly describes the progress made by the industry in production and sales both in this country and abroad. Production last year is estimated at 390,000,000 lb. of which 211,000,000 were sold in the United States and 139,000,000 were exported.

Natural gas is the only material which enters into the production of carbon black. It is commercially obtainable from this gas either (1) by the channel, disk or roller processes in which the gas is burned in hot houses through lava tips, in a limited supply of air, and the flame impinges on a relatively cool surface, or (2) by the Lewis process where the gas is burned in a furnace, with a limited supply of air, and the first step of collecting the black is to pass the smoke into water, or (3) by the Gastex process in which the gas is burned in a furnace, through special tips, with a regulated amount of air, and the black in the smoke is collected by electric precipitation, or (4) by the Thermatomic process in which case the gas is thermally decomposed and the resulting carbon is collected in bags.

Different grades of black are produced by each of the processes. The black made by the impingement processes (channel, disk or roller) is kncwn as channel gas black or carbon black. The black made by the Lewis, Gastex or Thermatomic processes is known as soft black. This black is weak in color strength and is not as good a reinforcing pigment. Its use is, therefore, chiefly that of a filler in certain rubber stocks where the black is desirable because of the ease with which it can be processed in the rubber. All-rubber fabric-free garden hose is one application in which this type of black is suitable.

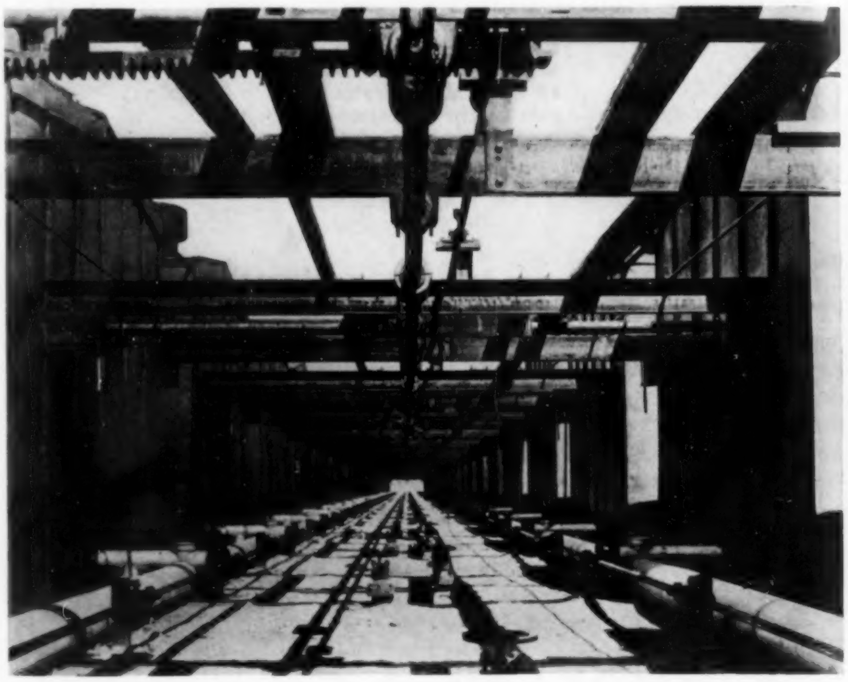
Last year approximately 350,000,000 lb. of black were produced by the channel process and 40,000,000 lb. by all other processes combined. The disk and roller processes are seldom used. The latter is employed only for the production of a special ink grade of black. Therefore while there are several processes used for the production of carbon black the channel process is by far the most important.

Commercial production of carbon black in the United States dates back to 1872 when a factory was established in New Cumberland, W. Va. The gas was burned against soap stone slabs and the black was scraped off. E. R. Blood patented the roller process in 1883 and L. J. McNutt the channel process in 1892. Production was moderate until 1912 when the reinforcing power of carbon black was recognized by rubber tire manufacturers. Since then the demand has greatly increased. Approximately 85 per cent of all the carbon black is being produced now in the Panhandle district of north Texas. There are also a number of factories in the northern part of Louisiana, near Monroe. Likewise, there is some black being manufactured in Oklahoma and in Wyoming.

With the exception of small amounts made in Russia, Japan and Roumania, the United States accounts for most of the world production. Commercial production of soft black commenced with the Lewis process at Hancock, La., in 1921. Shortly afterward the Thermatomic process began to operate at Sterlington, La. The Gastex process was established in 1928 at Pampa, Texas.

The determining factors which influence the selection of the natural gas as a raw material are: (1) nitrogen, (2) "sourness" or sulphur, (3) natural gasoline, (4) gas pressure, (5) proximity of the gas wells to the carbon black plant, and finally (6) industrial and domestic demand for the gas.

The more nitrogen there is in the gas, the smaller will be the recovery of carbon black. With the channel process, one can obtain 1.32 lb. of black per M cu.ft. of Oklahoma natural gas which contains 0.31 per cent nitrogen, whereas only 0.068 lb. of black can be obtained from Nocona, Texas, gas which contains as much as 41.27 per cent nitrogen.



Center alley of a carbon black factory at Borger, Texas

Sulphur is another factor which determines the selection of natural gas. Any gas which contains per 100 cu.ft. more than 1½ grains hydrogen sulphide, or more than 30 grains total sulphur is referred to as "sour." A gas that is below these specifications is termed "sweet." There is natural gas in western Texas which contains from 5 to 15 per cent hydrogen sulphide. Excessively sour gas is unprofitable for the manufacture of carbon black because of its corrosive action on the burner pipes. Recent legislation in Texas makes it mandatory from now on to use only sour gas for the production of carbon black. However, in Louisiana, Wyoming and in Oklahoma sweet gas may still be used. Purification of sour gas is too costly for the carbon black manufacturer.

Natural gasoline is a third factor in the selection of natural gas. The gasoline content in the gas may range from less than 0.1 gal. to more than 3 gal. per M cu.ft. Gasoline affects the recovery and quality of the black. Its removal is decidedly advantageous, for the carbon black manufacturer can receive more money for the gasoline as such than is obtainable by burning it to produce carbon black. Also, the natural gas will then be more uniform in composition and it is thus possible to produce a more uniform quality of carbon black. The gasoline may be removed by absorption in mineral seal oil, by compression, or by a combination of the two. It may also be removed by the charcoal process.

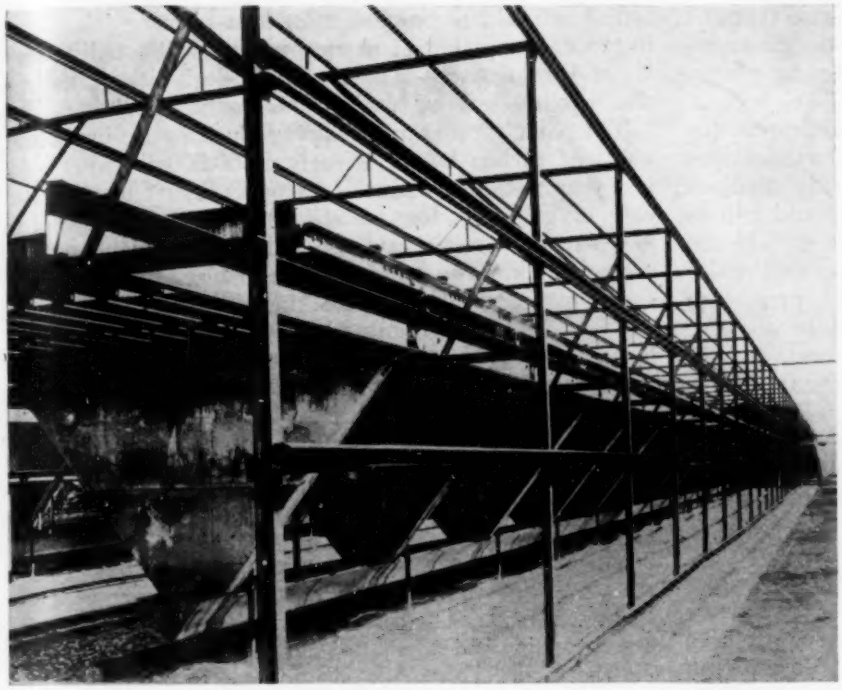
Gas pressure and proximity of the gas wells to the carbon black factory also influence the selection of the gas. Both determine the size and length of the pipe lines required to connect the wells to the plant. These pipe line connections are costly.

A modern carbon black factory which uses the channel process contains: metering device for measuring the gas, burner or "hot" houses, distribution pipe lines for feeding the gas to each and every part of the hot house, draft controls on each hot house, tips through which the gas is burned, channels on which the flames impinge, and scrapers for removing the black from the channels. There are also, hoppers, conveying system for transferring the black to the packing house, center alley with gears and shafting for actuating channels and conveyor screws, packing house, bolting system, agitator bins and carbon black packers. Weighing scales, system for converting the black into a non-dusting condition, cooling sheds for storing freshly packed black, carbon black presses, storage warehouses and a fully equipped control test laboratory complete the make up of the plant.

A group of from 30 to 72 hot houses constitute a unit, and there are usually several such units in each plant. Hot houses are separated from each other by side alleys. A center alley divides the unit in half. Tips are either of lava or metal and are specially designed, either with slots or with one or two holes, depending on the quality of black to be produced. A normally designed hot house may contain from 2,730 to 3,960 tips, and an average unit close to 300,000 tips.

Channels with their flat surface are placed downwards over horizontal rows of stationary burner pipes. These channels move with a reciprocating motion, being drawn slowly back and forth. The natural gas is burned through the tips to produce a continuous luminous flame in an insufficient supply of air. The flames impinge on the flat under surface of the channel. Carbon black is deposited on this flat surface, and also to some extent on the sides of the channel. It is then removed from each channel by fixed scrapers which are spaced over the top of each collecting hopper. The hoppers in turn connect with a trough, in which there is a conveyor screw that conveys the black from the hot house to a center alley conveyor and then to the packing house.

The recovery of channel carbon black from natural gas averages 1.43 lb. per M. cu.ft. of gas. This is equivalent to a recovery of slightly over 3 per cent of the theoretical. The recovery of soft black ranges from 3 to 10 lb. per



Burner house or hot house of a plant in process of construction

M cu.ft. of gas. The lower the recovery of soft black the nearer it approaches the characteristics of carbon black.

The packing house contains principally: (1) A series of bolters for bolting the black so as to remove foreign matter and "grit" (hard calcined particles of black); (2) An agitator bin where the flocculent black is subjected to turbulent agitation until most of the occluded air and gas in the black has been expelled and the black reduced to the proper bulk for packing; (3) Packers which load either 12½ or 25 lb. of black per bag. Rubber grade black is reduced in volume by compression to 22-26 lb. to the cu.ft. This does not quite eliminate the dusting tendency of the black. A granulized and practically dust free black, also bulking 22-26 lb. to the cu.ft., is now being offered to the trade. The granulizing may be performed in several ways, and the end product is generally sized by screening and then packed. This black is not subjected to any further compression. Stored black, especially if uncompressed, is first kept 24-48 hr. in a cooling shed, because of possible fire hazard. Compression or granulizing removes this hazard. All bags are over-slipped before they are removed from the plant for shipment.

The two other impingement processes for making carbon black, viz., the disk and roller processes have, respectively, disks and rollers as depositing surfaces for the black. The flames in the disk process are similar to those in the channel process. However, in the roller process they are candle-like in appearance, and this, together with the type of collecting surface, produces a special ink grade of black.

The soft blacks are furnace types of black produced by the Lewis, Gastex and Thermatomic processes. The Lewis process is described as having a special furnace in which natural gas is burned with a regulated amount of air to produce flames about 6 ft. in diameter. The black with the products of combustion appear in the form of huge clouds of smoke. It is collected in water, then allowed to settle, filter pressed, dried, reduced to a powder, and packed. In the Gastex process there is a furnace of special design in which the gas is burned through specially designed tips with a regulated amount of air, and the flames have unrestricted passage to the top of the furnace. The black is collected in an electric precipitator and is then packed.

The Thermatomic process also produces a soft type of black, but the process is quite different from the Lewis and Gastex. It is described as a batch process, which does not burn the gas, but decomposes it at high temperature from 900 to 1,300 deg. F. into hydrogen and carbon. The furnace somewhat resembles the super-heater of a water-gas machine.

In operation, the stack lid is closed and natural gas led in at the top and forced downward over a network of heated checker brick. The natural gas is decomposed into hydrogen and carbon. The products of decomposition leave at the bottom of the furnace, all the hydrogen and only about one-half of the carbon. The other half of the carbon remains on the surface of the checker brick. At the end of a short period the natural gas is shut off, the stack lid is opened, and a blast of heating gas and air is admitted at the bottom of the furnace. The combustion of this mixture and that of the black deposited upon the surface of the bricks pre-heat the brickwork to the desired temperature. At the end of a few minutes the natural gas is again decomposed. The carbon is cooled by passage through a water spray, and is then collected in a dust-collecting type of bag and packed.

In the channel process the deposit of carbon black on the flat surface of the channel consists of dark and gray black; the amount and intensity of color of each depending upon the burning conditions, tip adjustment and tip design. The black that is eventually packed off in the bag is a thoroughly blended composite of the dark and gray blacks.

The greatest demand for carbon black comes from the rubber industry. It is estimated that 182,000,000 lb. of carbon black were sold last year to the rubber industry in this country. The black is primarily used as a reinforcing pigment in tread stocks, in rubber soles and heels, and in sundry mechanical rubber goods. It is usually advisable to load a stock with sufficient carbon black in order to attain the maximum reinforcement. High grade tread stocks, for instance, require approximately 50 per cent by weight of carbon black based on the rubber used. This means that from 3.3 to 11.9 lb. of black are now required per tire, the amount of black depending upon the size, design and number of plies in the tire being manufactured.

Because mill room equipment and processing methods cover a wide range in the rubber industry, there are necessarily several rubber grades of carbon black for meeting the needs of the trade. Carbon black producers

have, accordingly, standardized on three general types of black, based on the degree of organic accelerator adsorption of the black. These are referred to as slow curing, medium curing and fast curing.

Curing rate is, however, not the only qualification for a rubber grade black. There are other qualifications which are equally as important. The mixing qualities of the black must be considered. Blacks should mill in quickly and disperse thoroughly in the rubber. If the dispersion is poor the stock will not stand up well under flexing and will, therefore, show signs of premature cracking. If extended milling is required to disperse the black, there is added power and labor cost, and, in addition, the nerve of the rubber is destroyed and the wear resistance of the stock will be lowered. Blacks that help the rubber to process more easily on the mill, on the calender, or in the tubing machine, do not always impart a high degree of reinforcement as evidenced from abrasion tests.

Another qualification of a rubber grade black is its particle size or fineness. Other conditions being equal a higher degree of reinforcement and better wear are obtainable with the finer particle black. Coarser particles cause less stiffening, and the stocks show lower tear resistance. Freedom from grit is an essential qualification of a good rubber grade of black. Grit particles are hard to disperse. Their presence in a tread stock will cause premature cracking (John N. Street, *Ind. Eng. Chem.* Vol. 25, p. 559 (1932).

Printing Ink Industry

The printing ink industry also has need for carbon black in the manufacture of news print, job, letter press, carton, bag, gravure and rotary inks. About 17,500,000 lb. were sold to the printing ink industry last year, of which 11,000,000 were used for news print ink and 6,500,000 for other inks. Printing inks may require from 8 to 30 per cent of black, depending upon the job the ink is required to do. News print ink requires from 8-12 per cent black. Job inks from 15-25 per cent. half tone inks from 15-25 per cent. Lithographic inks from 20-30 per cent. Carbon blacks for the printing ink industry must be uncompressed, of good color, grind easily, absorb oil readily, have a good top and under tone, likewise other satisfactory printing characteristics. A little black will accomplish a lot in a printing ink. For instance, one pound of news print ink will usually print about 4,000 newspaper pages and the legibility is attained with about 1.4 oz. of black in this pound of ink.

The paint, lacquer and enamel industries are important users of carbon black. Nearly 5,500,000 lb. were sold last year to these industries. Low bulk, jet black color, ease of grinding, low oil absorption and good suspension are characteristics these industries demand of the carbon black. The average grade of black does not meet the above specifications. It is, therefore, necessary to use special burning conditions to prepare a satisfactory black. The low recovery and extra care required in its manufacture make some of these grades expensive—as high as $1.10 a lb.

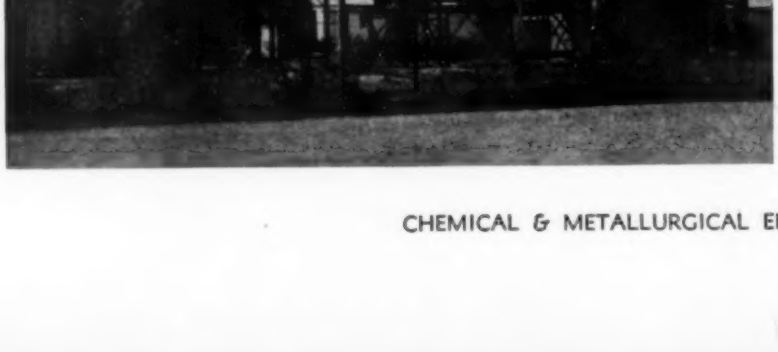
Carbon Black in Coating Paper

Carbon black is used in the coating of carbon paper, and in the manufacture of phonograph records. A jet black, low in oil absorption is required by these industries. Carbon black is also used for making concrete highways gray. The carbon black shades the concrete to a point where it deadens the glare of the sun's rays striking the road. This makes driving more comfortable and also helps to improve the appearance of the highways. The fluffy nature of carbon black makes it difficult to mix dry black with the concrete, and obtain good dispersion. The black is, therefore, supplied in paste form consisting of 25 per cent carbon black, a small percentage of emulsifying agent and the remainder, water.

The demand for the paste form of carbon black has steadily increased. There are a number of industries desiring a dark inexpensive inert coloring agent, but who are unwilling to use dry black because of its dusting tendency and the attendant difficulty in grinding to obtain good dispersion. The emulsified form of black has overcome these disadvantages.

There are also some novel uses for carbon black. One is in connection with liquid oxygen to produce an explosive which is even more powerful than dynamite. In another case the carbon black is mixed with cheap petroleum oil and spread in thin mixtures on frozen inland water ways. The heat of the sun's rays are retained longer by this black oil mixture and thus brings about a quicker thawing of the ice.

Lewis process plant for producing a soft type of black



TAPPI Becomes of Age

EDITORIAL STAFF REPORT

R. G. Macdonald re-elected secretary

William R. Maull of Dill & Collins, Inc. new vice-president

G. N. Collins of Stevens & Thompson Paper Co. has been elected president of TAPPI

MEMBERS of the Technical Association of the Pulp and Paper Industry assembled in New York, February 17-20, for the twenty-first annual meeting of the organization. One of the highlights of the meeting was the luncheon on the final day. Pres. Clark C. Heritage presided. He introduced the newly elected president, G. N. Collins, of Stevens & Thompson Paper Co. W. R. Maull of Dill & Collins, Inc., is the new vice-president and R. G. Macdonald, the re-elected secretary. William H. Millspaugh, president of Millspaugh, Ltd., of England, and for many years associated with the development of paper making equipment in this country, was awarded the Association medal. The presentation was made by W. G. MacNaughton of the Pulp & Paper Laboratories of the Industrial Committee of Savannah. Frank E. Gannett concluded the program with a discussion of "Tomorrow's Money."

One of the most important subjects considered during the convention was the preparation of specifications for chemicals used in the production of pulp and paper. General opinion favored such a program. It is probable that a beginning will be made with lime and soda ash. Eventually every chemical will be considered. John Traquair of the Mead Corp. introduced the subject of specifications and at his invitation Prof. James R. Withrow of the chemical engineering department, Ohio State University, and chairman of the A.S.T.M. committee for lime, discussed the lime specifications for sulphite and other purposes that had been established by his organization. He advised the paper industry to prepare specifications for each of the several principal uses for lime. Tentative specifications will probably be prepared by a committee representing the pulp and paper manufacturers. They will then be presented to the suppliers for their comments and recommendations before being finally adopted by the Association.

Materials of construction again came in for much attention. Several papers were presented on various phases of the subject. Committee chairman J. D. Miller commented on a change in the official standard specifications for chromium-nickel-iron castings. The slight revision in the specification is intended to clear up the occasional misinterpretation of supplementary *note 2* concerning the usefulness of molybdenum additions. The effect of molybdenum on corrosion resistance seems to be most pronounced in the lower ranges of chromium content allowed by the specifications; experience also has indicated that alloys containing chromium in excess of 28 per cent and nickel in excess of 9 per cent do not require a molybdenum addition to make them suitable for sulphite service. Consequently, the specification has been revised so as to make supplementary *note 2* read:

"There is plenty of experimental evidence demonstrating the power of molybdenum to contribute extra resistance to corrosion by sulphurous acid and calcium bisulphite and the committee considers its presence up to 4 per cent a distinct advantage in alloys containing less than 28 per cent chromium and 9 per cent nickel. It believes, however, that the specification of a molybdenum content may properly be left to the option of the purchaser."

The Materials of Construction Committee having embarked on a survey of the present uses of materials in the pulp and paper industry, Frank L. LaQue of the International Nickel Co. had been delegated to prepare a report on the uses of cast ferrous materials. He presented his report which was limited to materials having an iron con-

tent in excess of 50 per cent. The applications are listed in the tabulation which appears at the bottom of this page.

Copper and its commercial alloys were described by James T. Kemp of the American Brass Co. The physical properties of copper can be varied at will within the limits of severe cold working on the one hand and soft annealing on the other, according to Kemp. Other metals are added to copper to make a series of ductile alloys, within definite limits of composition, all stronger than copper itself, with valuable properties, and like copper, capable of being hardened by cold work or softened by annealing.

Proposed insulation specifications for the paper industry were discussed by J. W. Hemphill, Johns-Manville Sales Corp. and a member of the Materials of Construction Committee. The committee believes that some real service can be given the paper industry by presenting a foundation upon which to build data relative to insulating specifications. Criticisms are requested.

A survey of the situation revealed the fact that from 30 to 40 per cent of the conversion cost in making paper was tied up in the production and utilization of steam. Among other interesting remarks the speaker said:

"We also found the paper mills installing higher pressure steam generating plants and new chemical equipment, particularly in the recovery plants, all of which necessitates more specialization in insulating materials.

"In the selecting of insulating materials certain inherent characteristics are necessary to make them adaptable. In the first place they must be in such form as to be easily applied. For handling temperatures above that of atmosphere, insulations must have heat-resisting qualities sufficient to withstand successfully the highest temperatures to which they will be applied. They must be strong and durable to assure long life.

"For the low temperature field which is relatively of minor importance to the paper industry we find insulations made from organic and inorganic materials being widely used. However, since our consideration is chiefly with temperatures above atmospheric we shall stress only those materials commonly known as heat insulations. From such basic mineral products as asbestos, magnesium and calcium carbonate, diatomaceous silica, mineral wool made either from argillaceous limestone or various slags, mica, monohydrate bauxite, and processed clays, are made insulations in the form of sectional pipe covering; insulating sheets, blocks, bricks and blankets; insulating cements, fillers and finishes; and insulating boards, papers and felts. It is rather inevitable that many of these insulating materials are suitable for the same temperature field and they have certain inherent characteristics that may warrant their use on many different applications. However, your Committee has set up certain standard specifications for insulations which have been tested out in the field over a period of years and have proven their effectiveness."

Many interesting papers were presented on such subjects as alkaline pulping, stuff preparation, coated paper, mechanical pulping, heat and power, paper testing, color, containers and graphic arts, and fundamental research.

Applications of Cast Ferrous Materials in the Paper Industry

Application	Materials Used
Log conveyor sprockets and gears	Malleable iron, plain and alloy cast iron
Log conveyor buttons	Chilled iron, alloy chilled iron
Barker gears	Plain and alloy cast iron
Grinder cylinders	Plain and alloy cast iron
Grinder saddle	Plain and alloy cast iron
Grinder reverse valve	Plain and alloy cast iron
Grinder dressing knurls and burrs	Alloy chilled iron
Sliver and fine screen gears, frames, and supports	Plain and alloy cast iron
Diaphragm screen cams and frames	Plain and alloy cast iron
Centrifugal screen impellers, gears, frames and supports	Plain and alloy cast iron
Cylinder mould spiders and gears	Plain and alloy cast iron and Ni-Resist
Vacuum thickener gears, trunnions and valves	Plain and alloy cast iron and Ni-Resist
Disintegrator gears	Plain and alloy cast iron
Disintegrator anvils	Plain and alloy chilled iron
Chipper discs	Cast steel and chilled face alloy cast iron
Chipper gears	Plain and alloy cast iron
Chipper frame and housing	Plain and alloy cast iron
Sulphur burner nozzles	Stainless steel
Hot sulphur dioxide gas lines	Plain and alloy cast iron, Ni-Resist and stainless steel
Sulphur dioxide gas blowers or fans	Stainless steel
Lime rock crushers	Plain and alloyed cast steel, alloy chilled iron
Tower acid pumps, valves and lines	Stainless steel
Sulphite cooking acid pumps, valves and lines	Stainless steel
Sulphite digester cover liners	Stainless steel
Sulphite digester relief strainers	Stainless steel
Sulphite digester relief valves and lines	Stainless steel
Sulphite digester test cocks	Stainless steel
Sulphite digester top and bottom sleeves	Stainless steel
Sulphite digester bottom cross, discharge valves and steam check valves	Stainless steel
Sulphite digester thermometer wells	Stainless steel
Sulphite digester blow lines and target plates	Plain and alloy cast iron, Ni-Resist and stainless steel
Sulphite digester circulating system pumps and lines	Stainless steel
Sulphite digester hot acid system educators	Stainless steel
Sulphite digester hot acid and circulating system pipe lines, valves and fittings	Stainless steel
Soda and sulphate pulp digester valves and fittings	Plain and alloy cast iron, Ni-Resist and stainless steel
Black liquor filter spiders, valves and trunnions	Plain and alloy cast iron and Ni-Resist
Black liquor pipe lines, valves and fittings	Plain and alloy cast iron and Ni-Resist
Black liquor pumps	Plain and alloy cast iron and Ni-Resist
Black liquor evaporator bodies	Plain and alloy cast iron
Rotary furnace drive gears and pinions	Plain and alloy cast iron
Rotary furnace discharge lips	Plain and alloy cast iron and Ni-Resist
Smelting furnace spouts	Plain and alloy cast iron and Ni-Resist
Green liquor pumps, pipe lines, valves and fittings	Plain and alloy cast iron and Ni-Resist
Causticizing tank agitators	Plain and alloy cast iron and Ni-Resist
Caustic pumps, pipe lines, valves and fittings	Plain and alloy cast iron and Ni-Resist
Rag thresher gears and frame	Plain and alloy cast iron
Rag cutter gears and frame	Plain and alloy cast iron
Rotary cooker gears	Plain and alloy cast iron
Straw cutter gears and frame	Plain and alloy cast iron
Paper shredder rolls and gears	Plain and alloy cast iron
Cooker false bottom spiders	Plain and alloy cast iron and Ni-Resist
Bleach lines and pumps (calcium hypochlorite)	Plain and alloy cast iron and Ni-Resist
Alum pumps, piping and valves	Silicon iron
Beater tubs	Plain and alloy cast iron
Beater drive gears, pulleys and sprockets	Plain and alloy cast iron
Stock chest agitator gears and propellers	Plain and alloy cast iron
Stock pumps, liners and gears	Plain and alloy cast iron and Ni-Resist
Jordan engine shells, plugs, pulleys and frame	Plain and alloy cast iron and Ni-Resist
Fourdrinier frame and gears	Plain and alloy cast iron
Press rolls	Plain and alloy cast iron and Ni-Resist
Dryer rolls and heads	Plain and alloy cast iron
Dryer gears and frame	Plain and alloy cast iron
Calender rolls	Plain and alloy chilled iron
Crepe paper rolls	Alloy cast iron
MISCELLANEOUS	
Pipe lines, valves and fittings	Plain and alloy cast iron and Ni-Resist
Feed water pumps	Plain and alloy cast iron and Ni-Resist
Hydraulic turbine runners	Plain and alloy cast iron and cast steel, Ni-Resist, stainless steel
Grate bars and stoker parts	Plain and alloy cast iron and Ni-Resist
Paper plate dies	Invar type cast iron
Various machine frames, gears, sprockets, pulleys, bearing blocks and housings	Plain and alloy cast steel and plain and alloy cast iron

Readers' VIEWS AND COMMENTS

Research vs. Muddling

To the Editor of Chem. & Met.:

Sir—Several references in your February issue to the rôle of research in the development of a new product of process industries call to mind some of the false ideas and pitfalls one is likely to find along this particular path. A number of years of experience in business, in research and more recently in production convinces me that the average corporation executive and business man still have much to learn about this subject. Industrial research, in a sense, is similar to advertising. Both are a means of increasing business if properly used. But both can also be bottomless wells into whose depths money can be poured without return.

The word "Research" calls to mind great intelligences applied to problems with snap, precision, neatness and the use of the latest equipment and knowledge. Unfortunately, this is not true, for research workers are only human and the work turned out ranges from the ideal to plain muddling.

Research in its truest sense is an attitude of mind, rather than a mysterious technical process, and this attitude is more important to the research worker than any string of academic degrees. Research above all calls for a keen open mind which will impartially weigh all facts including those that are obnoxious. An obnoxious fact is one which is not in accord with our own beliefs. The man who cannot subordinate his prejudice, who cannot readily change his point of view and abandon a pet hypothesis would do well to seek success in other fields.

And if it is important that the research worker be open-minded, this quality is paramount for the research executive. He who egotistically shuts his mind to all ideas which do not fall in line with his own pre-conceived notions, who takes the "I know all—you don't know the half of it" attitude, is, as it were, a barnacle on the hull of progress. Such a man can nullify a corporation's appropriation for research and can turn a Research Department into a House of Muddling.

While on the subject of hypotheses, it may be well to recall the words of that keen thinker of the last century, Henry Thomas Buckle. He said "No really fruitful experiment can be made unless it is preceded by a judicious hypothesis. In the absence of such a hypothesis, men may grope in the dark for centuries, accumulating facts without obtaining knowledge." These words should be over the entrance to every laboratory, figuratively if not literally. Much that passes for research is in reality nothing but the aimless accumulation of facts. Verbose reports expand the files but not with wisdom. It undoubtedly is fortunate for many highly publicized research departments, that the boards of directors are in ignorance of the true state of affairs.

The research department itself should stand on equal footing with the sales and manufacturing departments and its executive should report directly to the head of the company. In such a position it could act as a cement between the sales and the manufacturing departments and could translate the requirements of the former into the produce of the latter.

Closer Alliance With Sales Needed

This question of the status of the research department in an industrial organization is important. The usual procedure is to place it under the manufacturing department, probably because its primary task is the improvement and the development of the products of this department. Actually there is no more reason for this than there would be to place the manufacturing under the sales department because the latter sold the products of the former. By having the research organization independent of both the sales and manufacturing departments, it could serve both to better advantage. There is a tremendous field which can be opened up by the combined efforts of the sales and research departments.

A research department should be keenly alive to, and intimately in touch with the tastes and trends of desire of the company's customers. It is only by keeping in close contact with the market that the needs of the present can be seen and the trends in the future can be envisaged.

It is not enough that the director of research be acquainted with market conditions. Every man in the department must know them. Each must have a complete understanding, not only of the company's but also of the customer's point of view, in order that the thought invoked while working on problems may be constructively focused.

Another advantage of having a research department independent from manufacturing would be that the former could then attack its many problems without the fear of well-meant but annoying meddling. Much of this meddling is due to false ideas regarding the methods of research.

Don't Penalize Ideas

A prevalent notion in some quarters is that the prime requisite in attacking a difficult problem is a complete freedom of preconceived ideas. In order to obtain this doubtful quality, it is usually necessary to use a man without the special technical training needed rather than one who has a background in the particular field of the problem. Too often those who should know better hearken to this sort of thing. No idea could be more mistaken. The more knowledge about a subject one possesses, the better he will be able to comprehend the scope of the problem and the more rapidly he will be able to solve it. This does not mean that the fresh point of view is not valuable, or that at times the services of outside technical specialists are not essential. The point is that for many problems, a sound knowledge of certain fundamentals and a disciplined mind capable of grasping all the points involved are indispensable. To place a man at work on such a problem without these qualifications, merely to obtain this lack of preconceived ideas,—as if ideas were not valuable—is to revert to the days of the alchemist. The outsider, no doubt, will be able to perform all sorts of spectacular and costly stunts, but that will be all. This kind of a performance is muddling and no research organization worthy of the name willingly engages in such tomfoolery. Unfortunately its occurrence is all too frequent.

Research must pay its own way. It is a vital every-day method of getting things done, not something to be placed on a pedestal and worshipped. Because research, in some cases, does not pay, is no reason for giving it up. Upon closer examination it often will be found that the reason for the failure lies in the substitution of muddling for research.

Industrial research in order to be effective must be intelligently focused on problems which will yield a profit to the supporting company. It must be free from hampering influences if the

greatest benefits are to be obtained. The personnel must be open-minded and have a thorough knowledge of fundamentals, the company's and the customer's policies and problems. While such a research organization cannot guarantee dividends to the stockholders, it is, however, the best possible insurance for continued existence that any company can possess.

FOSTER P. DOANE, JR.
Technical Superintendent,
Fort Edward Mill,
International Paper Co.,
Fort Edward, N. Y.

What Is the Reverse of Absorption?

To the Editor of Chem. & Met.:

Sir—We have recently had occasion to introduce in our works the unit operation that is the exact reverse of gas absorption. "Stripping" appears to be the commonly accepted term for this operation. Quoting Badger and McCabe in "Elements of Chemical Engineering," page 371 (1st Edition, 1931):

> A process that is the reverse of absorption is that of stripping. In this case a liquid containing a material in solution is stripped of this material by bringing the liquid in contact with a gas phase that is low in the material transferred so that the latter passes from liquid to gas.

Again, Walker, Lewis and McAdams in "Principles of Chemical Engineering" (2nd Edition, 1927) page 667, refer to the treatment of liquids by gases or vapors as "stripping." On pages 672-3 of the same text the term is extended to the treatment of solids by gases or vapors (or the reverse of adsorption).

In metallurgical operations, the term stripping is familiar, referring usually to the denuding of base metal bearing electrolyte of its principal constituent by continued electrolysis with insoluble anodes, with a view to withdrawing the solution from the main flow for subsequent removal of impurities or for discard. A second use of the term "stripping" in metallurgical operations refers to removal of electrodeposited metal from a cathode blank, as for example, in electrolytic zinc production.

In view of the close alliance between chemical engineering and hydro-electrometallurgical operations, confusion must surely occur over the term "stripping."

Two other terms defined as the exact reverse of absorption have come to our notice, namely, "desorption" and "exsorption." Walker, Lewis and McAdams, page 714, refer to the removal of ammonia from water by means of air as "desorption." This expression has also been used to mean the reverse of adsorption, for example, the liberation of adsorbed hydrogen from palladium (Chemical Age Dictionary). "Exsorption" appears to be a newer term, and was used in a recent discussion of the principles of the reverse process of absorption. (*Chemical Trade Journal and Chemical Engineer,* May 11, 1934, pp. 355 and Aug. 17, 1934, pp. 115).

Both of the above terms appear to be incorrectly derived from the Latin verb "sorbere" to suck in. Thus absorb literally means "to suck in from." The prefix "de" or "ex" with the root "sorbere" is quite meaningless.

A discussion of the above would no doubt be of considerable interest to chemical engineers and metallurgists.

F. H. CHAPMAN
Secretary, Research Board,
Consolidated Mining & Smelting Co., Ltd.,
Trail, B. C.

Looking for A Rare Bird

To the Editor of Chem. & Met.:

Sir—Perusal of Dr. Perry's interesting article on "Man Location" in your February issue prompts the following "food for thought": It is indeed a rare engineer, and a still rarer research man, who realizes that there are certain lines of thought connected with the commercialization of a project—that is, making a continuous profit over a period of years—that are beyond him unless he has put in several years of intensive effort. There are numerous lines of endeavor which I should like to discuss as time goes on which do more to cause commercial failure of new products than all of the other causes combined.

At the moment I refer to the following stumbling blocks or obstacles: (A). Patent attorneys who "know" they can prepare and prosecute an invention with only the casual consultation of the inventor. (B). Inventors, researchers or engineers who "know" they have covered the field. (C). Researchers who deify the idea and underemphasize the working out of the idea.

Call the man what you will, but the difficulty will be to locate him who can: (1). Comprehend a new field of endeavor. (2). Think out all the ramifications. (3). Prepare the patent applications. This cannot be done by two men as it is impossible for one man to know everything the other man thinks. (4). Prosecute the applications. (5). Build the patent situation so the patents do not just serve as hints for others to work out better processes.

As a matter of verification of my supposition as to the rarity of individuals adequately trained in this line, a recent advertisement in a technical journal for a man possessing these talents resulted in a flood of applications of those who said they *could* qualify—but not one from anyone who *had.*

"CORRESPONDENT"

Another Mellor

A COMPREHENSIVE TREATISE ON INORGANIC AND THEORETICAL CHEMISTRY. Vol. XIV. 1935. By *J. W. Mellor,* D.Sc., F.R.S. Longmans, Green, and Co. London and New York. 892 pages. Price, $20.

Reviewed by *A. P. Hartlapp*

THIS VOLUME contains the concluding section on iron, and the complete study of cobalt. The treatment is extremely thorough, the subject matter is rich in detail, and comprehensive references follow each subdivision. Frequent graphs aid in the clearer understanding of the author's deductions. The use of triangular diagrams for representing the properties of three-component systems is most effective.

The following compounds are taken up in detail: ferrous fluorides and chlorides; ferric and ferrous chlorides; ferrous bromides, iodides, and sulphides; ferric sulphides; pyrites; simple and complex salts of ferrous sulphate; ferric sulphate and the basic sulphate; complex salts with ferric sulphate; ferrous carbonate; ferrous and ferric nitrates; ferrous and ferric phosphates.

A complete history of cobalt ore is given. Occurrence, the physical and chemical properties, methods of extraction, and its uses are all scientifically handled. Furnace and leaching processes are discussed in detail. Preparation of metallic cobalt, and the separation of cobalt from nickel are given prominence.

The compounds studied are the numerous oxides; cobaltic chloride, amine, bromide, iodide, sulphate, carbonate, nitrate, and the complex salts of each; cobaltous chloride, bromide, iodide, sulphate, carbonate, nitrate, and phosphate.

High Pressure Gas Calculations

Correction: It has been called to our attention by Mr. John C. Whitwell of Princeton University that certain errors occurred in the article, "Calculation Methods for High Pressures," which appeared on page 32 of our January issue. In the numerical illustration of the second paragraph the value of $V = n\mu RT/P$, which appears as 0.1113, should have been 0.1213 cu.ft. per pound. Furthermore, the value given by the ordinary gas laws at the end of the same paragraph should have been 0.209 instead of 0.192.

Chemical Engineer's BOOKSHELF

Chemical Engineering In Petroleum Refining

PETROLEUM REFINERY ENGINEERING. By *W. L. Nelson*. McGraw-Hill Chemical Engineering Series, published by McGraw-Hill Book Co., New York. 647 pages. Price, $6.

Reviewed by *Howard W. Sheldon*

THE PETROLEUM INDUSTRY has been waiting a long time for a text such as this newest addition to the McGraw-Hill Chemical Engineering Series. Professor Nelson has presented his material in a clear, understandable manner and without doubt this text will be of real value alike to students of petroleum refinery engineering and to plant engineers and supervisors. A large number of practical examples of engineering problems are presented in a manner that forms an excellent pattern for the young engineer to follow. Sufficient detail for the use of the practicing design engineer is not always included but having in mind the space limitations that apply to any book, it must be apparent that a text which covers fundamentals as well as this one does is indeed commendable.

The book is divided into four parts, beginning with a brief résumé of the history and development of petroleum refining and continuing in the second part with a presentation of the fundamental data. Although somewhat abbreviated, this portion has a very commendable chapter on the evaluation of oil stocks.

The third part deals with the principles of design and closely parallels the standard textbooks in chemical engineering with special reference to petroleum technology. There is a chapter on corrosion which is entirely too concise for a subject of such vital importance to the refiner. The fourth part discusses the various processes used in refining, particular attention being given to distillation and cracking, with considerable emphasis on the various units required for the proper functioning of these processes. Lack of descriptive material covering some of the more recently developed processes for chemical refining and dewaxing is particularly noticeable and yet easily understood when one considers the fact that technology in this field is changing daily.

The volume is concluded with a chapter on economics which is admirably handled. On the whole "Petroleum Refinery Engineering" is a welcome addition to the refinery engineer's library and Professor Nelson should be congratulated for his effort.

Resins and Plastics

THE CHEMISTRY OF SYNTHETIC RESINS. By *Carleton Ellis*, Vols. I and II. Published by Reinhold Publishing Co., New York. Vol. I. pp. 1-829, Vol. II, pp. 830-1,615. Price, $19.50.

Reviewed by *S. D. Kirkpatrick*

WHEN "Synthetic Resins and Their Plastics" first appeared in 1923, there was no plastics industry in the sense that term is used today. Many important industrial developments were well underway but there had been no determined effort to bring together and correlate divergent interests that were competitive and yet basically inter-related and inter-dependent. The author's contribution to this coalescing process may not have been evident at the time but in the dozen intervening years all of the trends have been in the direction of coordination. An important industry has resulted and no small measure of the credit is due to the pioneering of the Ellis book.

In these same intervening years there has likewise been a growing recognition of the underlying nature and causes of resinification and the fundamental chemical and engineering principles common to the whole field of resins. It was this that led to the change in title to emphasize "The Chemistry of Synthetic Resins," without, however, neglecting the practical phases of production technique and plastic molding. A greatly enlarged edition was required to cover adequately the almost overwhelming number of new developments.

In this brief review it is possible only to indicate the general pattern of the present comprehensive work. Following informative introductory chapters on definition and classification and underlying principles of resin formation, polymerization and condensation, are more than 60 sections dealing with type resins, their characteristics, constitution, production and use. The phenol-aldehyde types receive fullest treatment in 10 chapters of 212 pages; the alkyd resins are next with 9 chapters of 128 pages while urea types follow in 7 chapters of 122 pages. The polyvinyls, rubber resins, cumarone, furfural, gum and wood rosins and esters, sulphur and many natural and miscellaneous synthetic resins are included.

A list of trade names, based in considerable part on the compilations of Dr. Alan F. Randolph that have appeared in *Chem. & Met.* annually since 1931, forms a convenient reference source. And it goes without saying that the name and subject indexes of more than 200 crowded pages of 6-point type are probably the most valuable information tools available to investigators in this field.

The tremendous amount of exacting effort required for a work of this sort is not always appreciated by the user. Casual inquiry from the author brings forth a hasty estimate of approximately 70,000 man-hours, or 10,000 man-days or 30 man-years. Our guess is that that is all too low. The fact remains that this is a tremendous contribution to science and industry viewed from any vantage point.

Power Maps

FEDERAL POWER COMMISSION MAP No. 1—Service Areas—Unmounted, in two sections, $7.50; Mounted on linen, with reinforcing rails, $10. Map No. 2—Plants and Transmission Lines—Unmounted, in two sections, $5; Mounted on linen, with reinforcing rails $7.50. Educational institutions and public agencies receive a discount of 40 per cent.

THE Federal Power Commission has published two important utility maps compiled by its National Power Survey, one showing the service areas and the other the chief generating plants and transmission lines of the principal electric utility systems in the United States. In full colors, one of these large wall maps is 51½ by 81 in. and the other 57½ by 84 in. Each covers approximately 90 per cent of the industry of the United States.

Map No. 1, "Service Areas of the Principal Electric Utility Systems in the United States, 1935," identifies separately 57 major utility systems, and 8 large municipal systems, and 50 minor holding companies and independent operating companies, represented in color. The systems shown include approximately 600 operating companies.

Map No. 2, "Principal Generating Plants and Electric Transmission Lines of the United States, 1935," indicates

345 hydro-electric plants, totaling 8,-187,914 kilowatts capacity, and 709 fuel generating plants, totaling 22,350,114 kilowatts capacity. Transmission lines totaling 135,000 circuit miles are shown.

MEN, MONEY AND MOLECULES. By *Williams Haynes.* Doubleday, Doran & Co., Inc., New York. 186 pages. Price, $1.50.

STRANGE, how prevalent is this M-alliteration in chemical industry. Many years ago in a Modernization Issue, *Chem. & Met.* mentioned "men and money, metals and materials, methods and machinery, markets and merchandising methods." Now comes the author of "Modern Miracles" with much more masterful material on "Men, Money and Molecules," that starts with an interesting chapter on "Molecule Making" and follows, in militant manner, with munitions and magicians. But lest the reader who abhors alliteration is already disgusted with this review, we must state that the book itself does not suffer seriously from this sin. Rather, Mr. Haynes, by recasting in more popular form his "Chemical Economics" has made a constructive contribution to the lay literature of chemical industry.

DIE VERFAHREN DER ANORGANISCH-CHEMISCHEN INDUSTRIE. By *Dr. W. Siegel.* Band I, Berichtsjahr 1934. Verlag Urban und Schwarzenberg, Berlin. 1935. 501 pages. Price, 30 Rm. paper, 34 Rm. cloth.

Reviewed by *A. P. Hartlapp*

THIS IS the first volume of a new series of annual reports covering in a systematic and concise manner the world-wide development of processes in the inorganic chemical industry. By confining his exposition to bare essentials, the author has succeeded in setting forth the patents and bibliography of all leading countries. He has covered a tremendous territory—acids, bases, salts, oxides, and metalloids.

In view of the immense mass of material to be included, he has presented only the essential part of each process, but that in a very clear and comprehensible manner. When interest appeared sufficient, comparison has been made with present practice. To illustrate the salient features of the various inventors' schemes, concrete examples and sketches have been given. In the great volume of patents described, those dealing with aluminum compounds, ammonia and ammonia compounds, sodium compounds, sulphur and sulphur compounds, and zinc compounds have been treated at greatest length.

This should be of considerable value as a reference book for chemists, research workers, and technologists interested in any of these fields.

HARTMETALLWERKZEUGE. By *Dr. Ing. Karl Becker.* Verlag Chemie, G.m.b.H., Berlin. 215 pages. Price, 13.50 Rm.

THIS monograph describes hard-facing of cutting tools, i.e. where a tip or point of a very hard alloy, usually tungsten or titanium carbide, is welded to the wearing parts of ordinary steel. The special alloy possesses a high degree of resistance to abrasion, and remains hard even at red heat, which would cause failure in the best high-speed steel tools. Since the base metal is usually carbon steel, such tools are not expensive, and worn tools frequently can be reclaimed by re-facing.

The writer directs especial attention to the proper welds and shows how to obtain long life at minimum cost, and how to prevent unnecessary damage. The practical application of these tools, and their wide use in metal industries is thoroughly explained. The hard-facing of special tools used in wood-working, coal or general mining, glass-making, ceramics, and wire drawing, has also proved highly effective. Tables showing cutting speeds and feeds for various metals and materials are included. Of especial interest to the patent attorney is the complete résumé of German patents applicable to the process.

RECENT BOOKS AND PAMPHLETS

Solubility of Non-Electrolytes, by Joel H. Hildebrand. Reinhold Publishing Corp., New York, 1936. 203 pages. Price, $4.50. Second edition of American Chemical Society Monograph.

Review of Oxidation and Scaling of Heated Solid Metals, by various British experts. Published in London, 1935. The British Library of Information, New York. 103 pages. Price, $0.80.

Graphic Course of Patentable Inventions, by H. A. Toulmin Jr., D. Van Nostrand Co. Inc., New York, 1936. 40 pages. Price, $1.

Steel Plates, Catalogue 132, Information and tables of data concerning fabrication and use of steel plates, Bethlehem Steel Co., Bethlehem, Pa., 1935. 361 pages. Price, $1.—A useful handbook.

Munitions Industry—Minutes of the War Industries Board from Aug. 1, 1917 to Dec. 19, 1918. United States Government Printing Office, Washington, 1935. 625 pages. Interesting pages from a critical period in history of chemical industry.

Electrolytic Oxidation and Reduction: Inorganic and Organic, by S. Glasstone and A. Hickling. D. Van Nostrand Co., Inc., New York, 1936. 420 pages. Price, $9.50. Vol. 9 of Monographs on Applied Chemistry edited by E. Howard Tripp.

Fluorescence Analysis in Ultra-Violet Light, by J. A. Radley and Julius Grant. D. Van Nostrand Co., Inc. New York, 1935. 326 pages. Price, $7. Second edition of Vol. 7 of Monographs on Applied Chemistry edited by E. Howard Tripp.

A Brief Course in Qualitative Chemical Analysis, by Louis J. Curtman. The Macmillan Co., New York, 1936. 249 pages. Price, $2.25.

Colorimetric Methods of Analysis, by F. D. Snell and C. T. Snell. Vol. I: Inorganic, D. Van Nostrand Co., Inc. New York, 1936. 766 pages. Price, $9.50. Second edition of authoritative standard text of this field.

Power Plant Chemistry—by Augustus H. Gill. McGraw-Hill Book Co., Inc., New York. 1935. 228 pages. Price, $2.50. Fourth edition of what was formerly known as "Engine Room Chemistry."

Science and Socialist Reconstruction—No. 10, December, 1935, Moscow. 10 issues yearly. Abstracts and interesting summaries published in Russian.

The Preparation of Engineering Reports, by Thomas R. Agg and Walter L. Foster. McGraw-Hill Book Co., Inc. New York, 1935. 192 pages. Price, $1.75. Of value to chemical engineers.

The Mineral Industry During 1934, Vol. 43. Edited by G. A. Roush. Published by McGraw-Hill Book Co., Inc. New York, 1935. 739 pages. Price, $12. Latest and most complete information on many minerals and process-industry raw materials.

Petroleum—The Story of an American Industry, by American Petroleum Institute. New York, 1935. 95 pages. Price, 15 cents. Second edition of "Oil," bring the facts and figures up to date.

A.S.T.M. Standards on Petroleum Products and Lubricants, edited by Committee D-2. Published by American Society for Testing Materials, Philadelphia, September, 1935. 358 pages. Price, $1.75.

The Cracking Art in 1934, by Gustav Egloff and Emma E. Crandal. Universal Oil Products Co., Chicago, 1935. 196 pages. UOP Booklet No. 165. A complete patent review of 1934 and a short general survey.

Modern Glass Practice, by Samuel R. Scholes. Industrial Publications, Inc. Chicago, 1935. 344 pages. Price, $6.

The Municipal Smoke Problem, by H. B. Meller and L. B. Sisson. Mellon Institute of Industrial Research, Pittsburgh, 1935. 20 pages.

Alcohol Under State Liquor Laws—Summary and Analysis, by James P. McGovern. The Industrial Alcohol Institute, Inc. New York, 1936. Second edition of 346 mimeographed pages of authoritative legal information.

An Introduction to Physical Metallurgy, by Leland Russell Van Wert, McGraw-Hill Book Co., Inc. New York, 1936. 272 pages. Price, $3.

The Early Iron Industry of Connecticut, by Herbert C. Keith and Charles Rufus Harte. New Haven, 1935. 69 pages. Price, $1. An historic document of timely interest to all students of American industrial progress.

Antoine Lavoisier, by Douglas McKie. J. B. Lippincott Co., Philadelphia, 1936. 303 pages. Price, $2.50. This is not only the first complete biography of the father of modern chemistry but a valuable contribution to the history of the science itself.

Technokratie - Weltwirtschaftskrise un Ihre Endgultige Beseitigung, by Karl Resar. C. Barth Verlag fur Wirtschaft und Architektur, Wien I, 1935. 202 pages. The author develops a new system based on what we in America called "Technocracy," prescribed as a cure for all ills of our present economic situation.

Repertoire International des Centres de Documentation Chimique (International Directory of Centers of Chemical Documentation), by Office International de Chimie. Paris, 1935. 115 pages. The endeavor of this organization is to facilitate research on an international scale. This being a first publication, it is interesting but necessarily far from complete as far as the United States is concerned.

The Townsend Scheme. By Vaso Trivanovitch, with foreword by Virgil Jordan. Published by National Industrial Conference Board. 43 pages. Price, $1. A keen analysis of the economic fallacies and administrative impossibilities involved in a plan that has been cleverly foisted on the American public.

100 Years Into America's Future

THE NEXT HUNDRED YEARS: The Unfinished Business of Science. By *C. C. Furnas*. Published by The Williams & Wilkins Co., Baltimore, Md. 434 pages. Price, $3.

Reviewed by *S. D. Kirkpatrick*

EDITORS occasionally boast of ability to review books without bothering to read them. One of our colleagues, we recall, once contributed a classic when he succinctly summarized four ponderous tomes by remarking that "The proceedings of the World Conference weigh 11 lb." This is one time, however, when an editor-reviewer wants to go on record as having read every word in 31 chapters of a stimulating book.

He even went back and re-read, in part at least, the author's "America's Tomorrow," published by Funk & Wagnalls in 1932. The contrast is striking and a bit sobering in implication. Just consider the two sub-titles: In 1932, "An Informal Excursion Into the Era of the Two-Hour Working Day" and in 1936, "The Unfinished Business of Science." Frankly the first book had left us cold, yet a bit inclined to challenge the author's youthful optimism which has been aided and abetted by a Merle Thorpe foreword on "the rosy dawn of America's new day." Now, as we close the second book, we are again challenging, but this time it is the author's more mature pessimism that comes from a long parade of our scientific and social shortcomings, of the things that science has left undone in this widely advertised age of technical progress.

Those chemical engineers who have not read the January, 1936, selection of the Book-of-the-Month Club, or the sizeable sample that appeared in *Chem. & Met.* last month, have a treat in store for them. A member of our profession, distinguished for his ability in research and in chemical engineering education, displays here, first of all, a remarkable breadth of vision and scientific interest —treating as informingly and authoritatively in Part I (Biology) of the Battle of Eugenics and Genetics, Synthetic Hormones, Infective and Deficiency Diseases, even life and death—as in the concluding Part V (Social Consequences) where the risen tide of invention is directed toward "Leisure Without Lethargy" and finally, "The Life of Assurance." Parts II, III, and IV (Chemistry, Physics, and Engineering) fall in between with 200 interesting pages, again so broad in concept as to touch on hundreds of unpredictable ramifications of these basic sciences.

The contribution that makes this book as far as this reviewer is concerned, is the fresh, enthusiastic style with which the author tackles his job—whether it is describing the chemist's attempts to outdo nature with synthetic rubber or setting up the minimum standards of living toward which we should shoot if we are to have real economic progress as a result of our scientific advance. With this personalized enthusiasm is an infectious and pervading sense of humor. There is not a page, scarcely a paragraph, that fails to sparkle with a witty comment or subtle reference to thoughts of a lighter vein.

Hence this most unorthodox review—if such it is—of a book that chemical engineers will want to read—proudly and profitably.

REVIEW OF OXIDATION AND SCALING OF HEATED SOLID METALS. By the Department of Scientific and Industrial Research. His Majesty's Stationery Office, London. 103 pages. Price, 2s. 6d.

MANY useful data pertaining to the mechanism and rate of oxidation are presented. There is a careful analysis of the action upon ferrous and nonferrous metals and alloys, in different atmospheres and temperatures. One section deals with the nature and properties of the oxide layers formed, and the methods of preventing oxidation and of removing scale.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Pottery. Tariff Commission Report No. 102, Second Series, 15 cents. Household table and kitchen articles of earthenware and of china, porcelain, and other vitrified wares.

Recent Developments in the Foreign Trade of Japan. Tariff Commission Report No. 105, Second Series; 25 cents.

Dyes and Other Synthetic Organic Chemicals in the United States, 1934. Tariff Commission Report No. 101, Second Series; 15 cents.

Analysis of Miscellaneous Chemical Imports Through New York in 1935. Tariff Commission Release of Feb. 17, 1936; mimeographed.

Statistics on Alcohol, Fiscal Year Ended June 30, 1935. Bureau of Internal Revenue, separate mimeographed reports for alcohol, distilled spirits and rectified spirits and wines, and fermented malt liquors and cereal beverages.

Foreign Trade of the United States, Calendar Year 1934, by Grace A. Witherow. Bureau of Foreign and Domestic Commerce, Trade Promotion Series 162.

United States Foreign Trade in December. Bureau of Foreign and Domestic Commerce Release January 22, 1935; mimeographed. Gives summary for the calendar year 1935.

Foreign Commerce and Navigation of the United States, 1934, Vol. II. Bureau of Foreign and Domestic Commerce; $2.00 (buckram), 516 pages. Gives exports and general summary tables of foreign commerce.

Practice and Procedure Under the Export Trade Act. Federal Trade Commission, Foreign Trade Series No. 2.

Preparing Shipments to Cuba, by Ralph M. Sams. Bureau of Foreign and Domestic Commerce Trade Promotion Series 163; 10 cents. Documentation and consular and customs requirements.

Fuel and Power in the British Empire, by John R. Bradley. Bureau of Foreign and Domestic Commerce Trade Promotion Series 161; 15 cents.

Fish Meal. Bureau of Fisheries Investigational Report No. 31, on Effect of method of manufacture on the composition of haddock fish-meal proteins; and Report No. 32, on Drying cod and haddock waste, both by Roger W. Harrison and others; 5 cents each.

Explosibility of Agricultural and Other Dusts as Indicated by Maximum Pressure and Rates of Pressure Rise, by Paul W. Edwards and L. R. Leinbach. Department of Agriculture Technical Bulletin 490; 5 cents.

Preliminary Report on the Disposal of Oil-Field Brines in the Ritz-Canton Oil Field, McPherson County, Kansas, by C. J. Wilhelm and Ludwig Schmidt. Bureau of Mines Report of Investigations 3297; mimeographed.

Asbestos—Milling, Marketing, and Fabrication, by Oliver Bowles. Bureau of Mines Report of Investigations 6869; mimeographed.

A Note on the Use of Ultraviolet Lamps in Mines for Rapid Detection of Scheelite in Ores by Fluorescence, by William O. Vanderburg. Bureau of Mines Information Circular 6873; mimeographed.

A Study of the Occurrence and Amenability to Leaching of the Phosphorus Compounds in Some Red Iron Ores of Alabama, by Ellis S. Hertzog. Bureau of Mines R. I. 3294; mimeographed.

Sound Absorption Coefficients of the More Common Materials. Bureau of Standards Letter Circular 452; mimeographed.

Directory of Federal Statistical Agencies, Central Statistical Board, unnumbered document; mimeographed.

Quality of Linseed Oil for Government Use. Bureau of Standards Letter Circular 457; mimeographed.

Transparent Wrapping Materials. Bureau of Standards Letter Circular 455; mimeographed.

Annual Report of the Tennessee Valley Authority for the Fiscal Year Ended June 30, 1935.

Industrial Health and Safety. Publications of the Public Health Service on: Acute Response of Guinea Pigs to Vapors of Some New Commercial Organic Compounds, Part VIII, Butanone, by F. A. Patty and others, Reprint No. 1702; Roentgenological Appearances in Silicosis and the Underlying Pathological Lesions, by H. K. Pancoast and others, Reprint No. 1696; The Size Distribution of Industrial Dusts, by J. J. Bloomfield, Supplement No. 115 to the Public Health Reports; 5 cents each.

Mineral Production Statistics for 1934—Separate pamphlet from Bureau of Mines giving detailed statistics on Sand and Gravel; Natural Gas. Statistical Appendixes to Minerals Yearbook 1935; 5 cents each.

Mineral Production Statistics for 1935—Preliminary mimeographed statements from Bureau of Mines on: Silver mining and production; mine production of gold; lime; zinc; copper; slate; lead; lead and zinc pigments and zinc salts; copper, lead and zinc mining.

Your Plant NOTEBOOK

NOMOGRAPH FOR CALCULATION OF MIXTURES OF OLEUM AND SULPHURIC ACID

By D. S. Davis
Dale S. Davis' Associates
Watertown, Mass.

DETERMINATION of the proportions of oleum and sulphuric acid required for the preparation of a weaker oleum frequently take the form of some adaptation of the familiar Pearson's Square, as outlined by Santmyers and Fickenscher in the December, 1933, and March, 1935, issues of *Chem. & Met.*, respectively. Concentrations of the components are usually expressed on different bases: sulphuric acid as the percentage of total H_2SO_4 and oleum as the percentage of free SO_3. Proper account of this situation must be taken in applying the Pearson's Square method and recourse must be made to a conversion calculation before tackling the main problem.

There is evident need for a rapid graphical method where (1) the conversion feature is built into the chart and need not be considered in its use and (2) the desired proportions are given as percentages rather than as numbers of "parts." The accompanying chart handles the problem nomographically and its use is illustrated as follows:

What percentages of sulphuric acid (97.75 per cent total H_2SO_4) and oleum (30 per cent free SO_3) shall be mixed to yield an oleum testing 12 per cent in free SO_3? Following the key, connect 97.75 per cent total H_2SO_4 on the x-scale at the left with 12 per cent free SO_3 on the C-scale and note the intersection with the A-axis. Connect 97.75 per cent total H_2SO_4 on the x-scale at the right with 30 per cent free SO_3 on the C_1-scale and note the intersection with the B-axis. Connect the points so found on the A- and B-axes and read the desired percentages on the inclined axis as 55 per cent oleum and 45 per cent sulphuric acid. That is, a mixture containing 55 per cent of oleum (30 per cent free SO_3) and 45 per cent of sulphuric acid (97.75 per cent total H_2SO_4) will be an oleum with a content of 12 per cent free SO_3.

The chart is based upon the relationships,

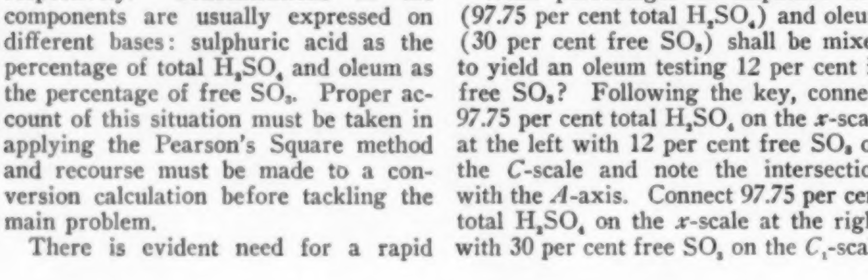
$$P_1 + P_2 = 100$$

$$C_2 = -4.44\,(100 - x) \text{ and}$$

$$P_1 = 100\frac{C - C_2}{C_1 - C_2} = 100\,\frac{C + 4.44\,(100 - x)}{C_1 + 4.44\,(100 - x)}$$

where P_1 = percentage of oleum (testing C_1 per cent free SO_3) in the mixture; P_2 = percentage of sulphuric acid (testing x per cent total H_2SO_4) in the mixture; C = percentage free SO_3 in the desired oleum; C_2 = percentage free SO_3 deficiency in the sulphuric acid; and 4.44 is the ratio of molecular weights of SO_3 to H_2O.

Oleum-sulphuric acid mixtures are easily calculated with this chart



Means for Detecting Iron In Alloy Equipment

By F. H. Hoyt
DuPont Viscoloid Co.
Arlington, N. J.

IT OFTEN HAPPENS that in plant equipment great expense is involved in the purchase of equipment made from stainless steel, nickel or other corrosion resisting materials. Not infrequently iron parts such as screws, nuts, rivets or pins are used by accident and if this condition is allowed to persist the resulting corrosion may result in considerable loss. The writer has found a simple method for discovering such iron, which may be used in any case where its presence would be detrimental either to the product or to the equipment.

This method entails no taking apart of the equipment or the running of extensive chemical analyses, yet it easily shows just which are the offending parts. One simply makes up a thick water paste of plaster of paris which is spread in a layer $\frac{1}{4}$ to $\frac{1}{2}$ in. thick over the parts in question. When the plaster has dried a yellow stain will appear through the plaster over every piece of iron. On the other hand, surfaces covering brass, stainless steel, nickel and other materials not affected by water will remain white. Thus the presence of iron can be detected through as much as $\frac{1}{2}$ in. of plaster.

News of EQUIPMENT

Polarizing Glass

A development which is expected to have far-reaching results in many fields, both consumer and industrial, is the new polarizing glass, Polaroid, recently announced by the Land-Wheelwright Laboratories, 168 Dartmouth St., Boston, Mass. The glass, which is the invention of a young Boston physicist, Edwin H. Land, is an almost colorless composite material, or sandwich, consisting of two plates of ordinary glass between which is sealed a thin sheet of cellulose acetate film of special type. The film contains in suspension, for each square inch, in the neighborhood of 1 thousand billion dichroic crystals, which are of synthetic organic nature, described as an alkyloidal iodide. Each crystal has the property of polarizing light, with the absorption of practically all the visible light in one of its plane polarized components, while transmitting a large proportion of the other component. A special process, believed to be a drawing operation, is employed to orient all of the crystals when they are put into suspension, so that their net effect is to make the sheet the optical equivalent of one large crystal.

The polarizing of light, it will be recalled, is an action which may be likened roughly to the combing out of the rays of light so that the vibrations which pass are entirely in one plane. Previously, it has been possible to produce polarization through the use of the nicol prism, a small and expensive natural crystal, and by other means which were inconvenient, expensive or unsuited to large sizes. The new material, however, is inexpensive and available in unlimited size. It is believed that it will be suited to most uses for which the earlier polarizing means were employed. In addition, it will be practical for many uses where polarization has formerly been impossible on account of expense or mechanical difficulties.

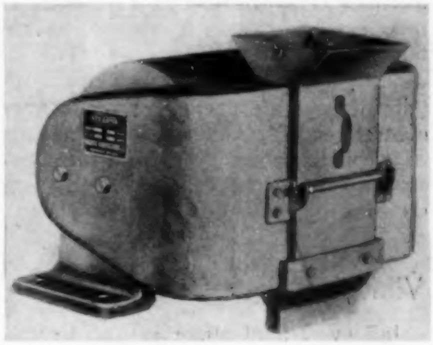
When light is reflected at certain angles it is polarized, which accounts for one of the first applications to be made of Polaroid. The material will shortly be available in the form of sun glasses with the plane of polarization crossed with respect to that of light that will be reflected from water or other surfaces. The glasses, then, will serve to eliminate the bulk of this reflection. Through the use of two motion picture cameras with lenses placed at eye distance, and two synchronized projectors projecting through sheets of Polaroid, one polarizing vertically, the other horizontally, a viewer equipped with glasses the lenses of which are similarly crossed will be able to observe practically perfect three-dimensional motion pictures. A modification of this scheme, employing only one camera and projector, with the right and left eye views on alternate frames, will shortly be available to the public for home motion picture work.

One of the most important uses of the new material will be in eliminating headlight glare. For many years automotive engineers have realized that the eventual solution of the problem would probably come through polarized light. The method is now available through the use of Polaroid windshields to replace the usual safety glass, and oppositely polarized lenses for headlights. The effect of this arrangement is practically to blot out, for a driver viewing them, the headlights of an approaching car, yet leaving the car itself entirely visible.

Many other applications have been suggested and still others will be discovered. These include the preservation of three-dimensional photographic records of all kinds, the study of stresses in photoelastic models and in glassware, the study of skin diseases and defects, the elimination of reflections in the viewing of paintings, the production of "one-way" windows for apartment houses and the making of slides to give brilliant "subtraction" color effects from colorless cellulose films.

Wet Separator

For the magnetic purification of such materials as clay slip, paints and similar products, the Magnetic Mfg. Co., Milwaukee, Wis., has introduced the new type QF separator which consists of a powerful stationary magnet energized by coil windings, designed to permit mounting a cartridge of auxiliary magnets in the magnetic circuit. This cartridge is said to contain an extremely large number of auxiliary magnets of special soft iron material. These become highly energized by the induced magnetic field. As the mixed material travels through the field, the fine iron particles encountered are readily attracted and securely held. When the current is disconnected, the cartridge tilts, thus permitting discharge outside the flow of finished product and preventing discharge of the removed particles into the cleaned material.



Type QF magnetic separator for liquids

Another new design announced by this company is the Type V machine, which is intended for removing minute magnetic particles from finely powdered materials. The machine consists of a cylindrical unit with flange end connections at top and bottom, containing a conical shaped magnet approximately 12 in. in diameter. The overall height is only 36 in. The machine is equipped with a vibrating type feeder to discharge material in a thin, even layer over the magnet. Separation is effected while the material is in suspension, assuring, according to the manufacturer, maximum magnetic attraction and positive elimination of fine magnetic particles. The housing is of non-magnetic stainless steel and the magnetic poles of steel, chromium plated to prevent corrosion.

High Speed Potentiometer

Extremely high balancing speed is a feature of a photoelectric, electronically balanced potentiometer that has been brought out by Weston Electrical Instrument Corp., Newark, N. J. The device is so rapid that it is being used in recording the temperature variations of a sheet of steel as it passes at its customary speed through a steel rolling mill. Balancing involving a full scale change in indicator deflection, it is stated, can be accomplished in a fraction of a second. The new potentiometer

is adaptable to the measurement of such process variables as temperature and pH, or in fact, any function that can be measured in terms of electrical units.

The potentiometer contains no moving parts with the exception of the mirror galvanometer which throws a light beam toward two photocells. Deflection of the beam from the center position sets up a differential in the illumination of the cells, which are in a bridge circuit connected to the grid and cathode of a vacuum tube. This changes the grid voltage and, in turn, electronically readjusts the indicating current to balance the circuit across a standard resistor and return the galvanometer to zero. In other words, the balance that is normally secured by the mechanical adjustment of a rheostat in this case is attained almost instantaneously by electronic means. The indicating current is of sufficient magnitude to operate meters, recorders or control relays. If desired, the company is prepared to supply a high-speed recorder said to be capable of utilizing the high speed of the balancing device.

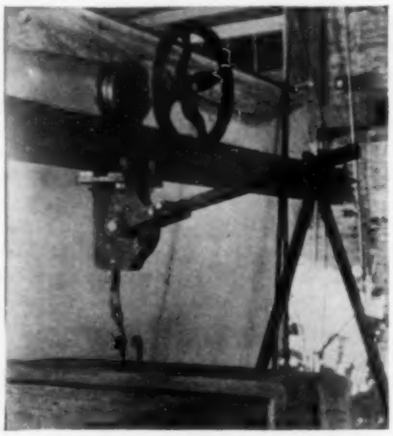
Vibrating Equipment

Jeffrey Manufacturing Co., Columbus, Ohio, has recently developed a number of new types of vibrating equipment including the new Jeffrey-Traylor barrel packer shown in the accompanying view. The vibrator employed operates from any standard a.-c. circuit, oscillating a flat platen on which the

Vibrating barrel packer

barrel rests. The amplitude of vibration is adjustable by means of a rheostat and the speed of vibration, 3,600 per min. The adjustment is said to make possible the attainment of maximum packing speed for a wide variety of materials and containers. The packer is said to impart no vibration to the building and to accomplish packing in about one-half the time ordinarily required. It is available in seven sizes for packages from 50 to 800 lb.

This company has also announced a new constant-weight feeder, consisting of an electrically vibrated feeder, controlled electrically by a balanced weighing belt equipped with an adjustable counterpoise for setting the desired rate of discharge. No gates are required to control the flow of material and a high degree of accuracy is said to be obtained. The unit, in one particular size, has a capacity range from 3 to 3,000 lb. per hour at an accuracy said to be plus or minus 1 per cent or better. A control box which may be located at the feeder or at some distant point carries flasher lights which at all times give visual evidence of correct operation.

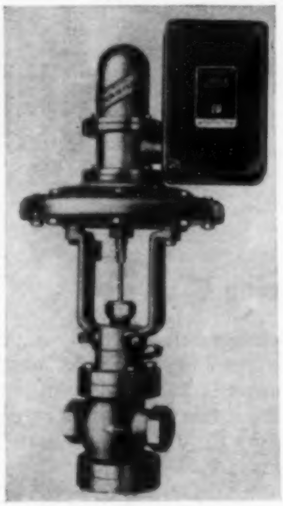


Lifter for Filter Plates
D. R. Sperry & Co., Batavia, Ill., has developed this shifting device for filter plates which makes it possible for one man to lift and shift plates weighing as much as 500 lb. A jacking device lifts the plate to clear the handles from the side bars. Turning of the traction wheel then shifts the plate horizontally along the press.

Improved Instruments

Foxboro Co., Foxboro, Mass., has announced a number of new instrument developments including an improved absolute pressure gage in which the pressure measuring and barometric compensation units are mounted together, forming a complete, integral actuating movement said to be of extreme accuracy. Two bellows units, one measuring direct pressure and the other barometric pressure, are so connected that their pressures directly oppose each other. The compensating bellows, which is sealed under full vacuum, exactly counterbalances the barometric effect on the main pressure measuring bellows.

This company has also announced a new accessory for air-operated control valves, known as the Vernier Valvactor. This device is said to eliminate valve sticking and assure highly accurate valve positioning by air-operated control instruments. This device is mounted on the control valve and can be installed in the field with but little interruption to service. It is claimed that a change



New valve-positioning device

of as little as 0.5 in. w.g. in the air pressure from the control instrument will cause a corrective positioning of the valve and force the stem to take a position within 0.001 in. of the previous one.

Equipment Briefs

Various large industrial companies, it is reported, have recently adopted as standard a new first-aid kit, known as the "Brac-Kit," which has been developed by the Davis Emergency Equipment Co., 55 Van Dam St., New York City. The kit consists of two baked enamel steel cases, an outer case to be permanently attached to a wall, and an inner case which, when needed, can be carried to the scene of the accident. The exact assortment of first-aid material depends upon the industry in which the kit is to be used.

A new goggle lens, said to have far greater impact resistance than any previously used in standard eye protection equipment, is now being offered by the American Optical Co., Southbridge, Mass. The new lens, known as the 6-Curve Super Armorplate, is said to get its extra strength from its high curvature. A 1-in. solid steel ball dropped on the lens from a height of 10 ft., in a test recently conducted at Massachusetts Institute of Technology, produced no breakage.

A mercury-tube toggle switch rated at 30 amp. at 125 volts, for use where explosion hazards exist, has been announced by the Hart Mfg. Co., Hartford, Conn. As the mercury tube is hermetically sealed, no exposed arc is possible, and corrosion of the contact surface is avoided.

An interesting electrical device, produced by the Enterprise Foundry Corp., 2900 - 19th St., San Francisco, Calif., has recently been put on the market under the name of Enterprise electric alternator. Power consuming devices, for purposes of safety and reliability, are frequently installed in duplicate. Customarily, one is held as a standby. The manufacturers of the new device claim, however, that a much better procedure is to utilize both pieces of equipment alternately. The new alternator will automatically alternate the circuit so that this can be accomplished. The device is said not to carry current when operated and to be incapable of arcing.

To reduce flicker of lights and interference with other electrical equipment in cases where two or more large synchronous motors are driving reciprocating pumps or compressors, a new electronic-tube, angle-switching device has been developed by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The new equipment prevents the compression strokes on different units from occurring in unison, thus reducing the magnitude of current pulsations. This company has also introduced a new 300-hp. 3,600-r.p.m. explosion-proof motor which is completely inclosed and self-cooled. All exposed parts with the exception of the shaft and blower are of cast iron to give maximum protection against corrosion. The motor is designed to give complete protection against explosive atmospheres containing gasoline vapor.

A close-coupled, motorized centrifugal pump, especially designed for handling volatile liquids near their vapor pressures, has been announced by Worthington Pump & Machinery Corp., Harrison, N. J. The new pump, Type DH, is available in capacities from 10 to 175 g.p.m. Depending on size, heads up to 110 ft. are possible. Power varies from 1 to 5 hp.

Exceptional oil resistance is claimed for a new pneumatic hose recently developed by the Republic Rubber Co., Youngstown, Ohio. The tube is compounded from material similar to that used in oil conducting hose and is said to possess great resistance to heat, high pressure, abrasion and atmospheric exposure.

Self-Contained Press

For various molding and pressing operations, the Watson-Stillman Co., Roselle, N. J., has developed a self-contained hydraulic press in which a gearless, electric-motor-driven pump within the base of the press supplies the necessary hydraulic pressure. The pump and valves are packless, the only packing being the fiber washers around the cooling coil connections in the oil reservoir and the U packing of the hydraulic ram. All seepage from the ram drains back to the reservoir. The pump is set in operation by means of a push button control and the movement of the ram controlled by a single lever. Release of the lever allows the ram to return to its open position under the pressure of springs mounted in the housings at the side of the press. The press is to be built in four or five capacities.


New self-contained hydraulic press

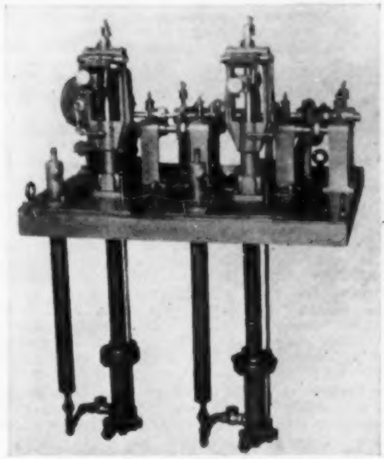
Sludge Pump

A new non-clogging design of centrifugal pump for handling pulpy materials, such as sewage, against high heads has been developed recently by the Morris Machine Works, Baldwinsville, N. Y. The pump has been designed to operate with a standard high-speed motor. It is completely self contained, with heavy-duty double ball radial and thrust bearings supported on an extension of the hub disk so as to maintain alignment of the bearings with the pump body. A floating suction ring is provided, so designed that solid particles will not interfere with its effectiveness as a seal between the suction and pressure parts of the pump. The impeller of each size will pass solids 1 in. smaller in size than the pump outlet. Pumps are built in sizes from 3 to 10 in., with open and enclosed impellers.

New pump for pulpy materials

Sulphur Pump

Said to be a material refinement over earlier designs, a new molten sulphur pump has recently been announced by Hills-McCanna Co., 2349 Nelson St., Chicago, Ill. In this pump the actual pumping unit and check valves are submerged in the sulphur. The device is double, providing a spare unit in case of emergency. Each unit may be removed from the pit without affecting the operation of the other. Either may be cut in or out of operation with the clutch arrangement shown at the rear in the accompanying view. Adjustment of delivery rate may be made during operation. An automatic cutout is provided in case the equipment is started before the sulphur has been reduced to the liquid state.


New dual-unit molten sulphur pump

Photoelectric Cell

"Electrocell" is the name of a new dry-disk, self-generating photoelectric cell, available in standard sizes from 1 to $2\frac{5}{8}$ in. in diameter, which is being distributed in the United States by Dr. F. Loewenberg, 10 East 40th St., New York City. This cell has a sensitivity of 350 microamperes per lumen in 500 ohms external resistance. A feature is that it may be produced in various shapes including round, square and oblong. It is said to have a wide color response from infra-red to ultra-violet.

MANUFACTURERS' LATEST PUBLICATIONS

Agitators. Mixing Equipment Co., Rochester, N. Y.—Leaflet illustrating and briefly describing several agitator types made by this company.

Agitators. Patterson Foundry and Machine Co., East Liverpool, Ohio—Leaflet portraying a wide range of agitator types made by this company.

Apparatus. Fish-Schurman Corp., 230 East 45th St., New York City—4-page bulletin describing the Hoeppler Ultra-Thermostat; leaflet on the Hoeppler precision stop-watch.

Apparatus. Precision Scientific Co., 1749 North Springfield Ave., Chicago, Ill.—Catalog 160—80 pages on a wide variety of apparatus for testing petroleum products.

Apparatus. Thermal Syndicate, Ltd., 72 Schenectady Ave., Brooklyn, N. Y.—Leaflet describing new line of refractory alumina laboratory ware announced by this company, giving properties, applications and prices.

Apparatus. Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Leaflet TD-23—6 pages on electrically heated laboratory apparatus.

Boilers. Combustion Engineering Co., 200 Madison Ave., New York City—Catalog H-5—12 pages illustrating and describing installations of Heine boilers.

Buildings. The Austin Co., Cleveland, Ohio—8-page booklet comparing advantages of single- and multi-story buildings.

Chemicals. Carbogen Chemical Co., Garwood, N. J.—17-page booklet describing properties of a series of alkyd type synthetic coating materials made by this company.

Chemicals. Commercial Solvents Corp., Terre Haute, Ind.—Leaflet describing advantages and uses of Shellacol, a solvent for many purposes made by this company.

Chemicals. Publicker Commercial Alcohol Co., 260 South Broad St., Philadelphia, Pa. —76-page spiral-bound booklet giving specifications, uses, methods of analysis, and commercial and reference data on alcohols, esters, proprietary solvents and ketones produced by this company.

Chemicals. Quaker Oats Co., 141 West Jackson Blvd., Chicago, Ill.—19-page booklet, "The Furans," discussing chemicals from oat hulls, i.e., furfural and its derivatives.

Condensers. The Trane Co., LaCrosse, Wis.—Leaflet describing this company's evaporator condensers for refrigerating and air conditioning installations.

Crushers. Traylor Engineering & Mfg. Co., Allentown, Pa.—Bulletin 105—10 pages on this company's Type H Blake jaw crushers; Bulletin 112, 14 pages on gyratory Type TY reduction crushers.

Dryers. Gehnrich Corp., Skillman Ave. and 35th St., Long Island City, N. Y.—Catalog 101—28 pages describing features of this company's ovens and dryers and illustrating numerous installations.

Electrical Equipment. Struthers Dunn, Inc., 139 North Juniper St., Philadelphia, Pa.—28-page catalog on relays, timing devices, thermostats, insulators, etc.

Engines. Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletin S-500-B30—8 pages on direct-injection, four-cycle diesel engines.

Equipment. Consolidated Products-Spreckles Liquidation, Yonkers, N. Y.—32-page book listing used equipment available in liquidation of Spreckles Sugar Corp.

Equipment. Ingersoll-Rand Co., 11 Broadway, New York City — Bulletin 2214 — 4 pages describing this company's steam-jet refrigeration method of gas cooling; Bulletin 3162, 36 pages describing this company's improved line of heavy-duty compressors in capacities from 50 to 250 hp.

Equipment. Jeffrey Mfg. Co., Columbus, Ohio—Catalog 620—64 pages on electric vibrating equipment for feeding, conveying, cooling, drying, packing and screening.

Erosion. Debevoise Co., 968 Grand St., Brooklyn, N. Y.—12-page booklet describing prevention of erosion in condenser tubes with this company's tube cement, Debecote.

Fiber Containers. Continental-Diamond Fibre Co., Newark, Del.—31 pages on fiber articles including trucks, cans, boxes, baskets, barrels and other hollow ware.

Flooring. Blaw-Knox Co., Pittsburgh, Pa. —Bulletin 1524—16 pages on this company's Floorgard, a steel mesh material for armoring concrete floors.

Furnaces—Hevi Duty Electric Co., Milwaukee, Wis.—Bulletin MU-1135—4 pages on laboratory muffle furnaces equipped with alloy No. 10 resistors for temperatures to 2,400 deg. F

Heat Exchangers. Struthers-Wells Co., Warren, Pa.—Bulletin 76—16 pages on this company's line of heat-exchange equipment.

Instruments. Cambridge Instrument Co., Ltd., 45 Grosvenor Place, London, S.W.1, England—Folder 51—16 pages illustrating applications of this company's automatic regulators to the controlling of electric, gas and oil fired furnaces.

Instruments. Cochrane Corp., Philadelphia, Pa.—Bulletin 2246—12 pages describing instruments and combustion controls produced by Hayes Corp., Carrick Engineering Co. and Cochrane Corp., offered in combination for use in centralized power plant instrumentation.

Instruments. Esterline-Angus Co., Indianapolis, Ind.—Bulletin 935—4 pages on indicating and recording electrical tachometers.

Instruments. The Foxboro Co., Foxboro, Mass.—Bulletin 198—48-page catalog covering the complete line of recording thermometers made by this company.

Instruments. Julien P. Friez & Sons, Inc., Baltimore, Md.—Bulletins W and E on a new effective temperature thermostat and window condensation control; Bulletins R, S and P on recording psychrometers, sling psychrometers, and electrically aspirated psychrometers.

Instruments. Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia, Pa. — Catalog N-93—16 pages on indicating, signaling and recording smoke density recorders; Bulletin 709-B, 12 pages on pH recorders in improved gassing of beet juices.

Instruments. Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.—Catalog 100—24 pages on this company's automatic controls for heating, air conditioning, refrigeration and industrial applications.

Instruments. Pyrometer Instrument Co., 103 Lafayette St., New York City—Catalog 70—6 pages illustrating and describing this company's improved optical pyrometers.

Lighting. Benjamin Electric Mfg. Co., Des Plaines, Ill.—Supplement Section XI-A, Catalog 26—28 pages on high intensity mercury vapor lamp fixtures of 400 watts rating.

Lubrication. Alemite, 1878 Diversey Pkwy., Chicago, Ill.—32-page catalog on equipment for industrial lubrication; also industrial lubrication manual giving lubrication recommendations and discussing various phases of lubrication.

Materials Handling. Chain Belt Co., Milwaukee, Wis.—Bulletin 266—Folder describing use of this company's belt conveyor idlers in various industries.

Materials Handling. Lewis-Shepard Co., Watertown, Mass. — Circular 317 — Illustrates a wide range of floor and lift trucks equipped with rubber-tired wheels.

Materials Handling. Palmer Bee Co., Detroit, Mich.—Sec. 111, General Catalog 100—64 pages on this company's skip hoist and drag line machinery for elevating and conveying.

Metals. Fansteel Metallurgical Corp., North Chicago, Ill.—48 pages with engineering data and technical information on properties and uses of Tantalum.

Metals and Alloys. International Nickel Co., 67 Wall St., New York City—Bulletin C-4—16 pages on Monel metal and nickel in manufacture of pharmaceuticals, fine chemicals and proprietary products; Bulletin C-3, 20 pages on Monel metal in pulp and paper mills.

Microscopes. Bausch & Lomb Optical Co., Rochester, N. Y.—14 pages on micro-projectors; 4 pages on spectrum measuring microscopes; 24 pages on polarizing microscopes; 18 pages on microscope illuminators.

Mixing. Baker Perkins Co., Saginaw, Mich.—Plastics Section, Catalog 35—35 pages on mixers, shredders, dispersers and ball mills made by this company for process industries.

Painting. Sherwin-Williams Co., Cleveland, Ohio—34-page book discussing relation between the painting and lighting of industrial plants, with discussion of requirements in a paint and illustrations showing effects of adequate and inadequate painting. Gives recommendation for unit lighting intensities, use of company's products.

Pipes. Eureka Pipe Co., 591 Washington St., Lynn, Mass.—4-page leaflet describing this company's centrifugal cement-lined pipe.

Power Transmission. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1261—12 pages on this company's new Vari-Pitch Texrope sheaves; also Bulletin 2188A, 16 pages on Duro-Brace Texsteel sheaves.

Power Transmission. Fafnir Bearing Co., New Britain, Conn.—Engineering Manual 35—197-page manual on ball and heavy-duty roller bearings, reviewing principles affecting selection, application and operation of anti-friction bearings, complete with lists of bearing types and sizes to facilitate selection.

Power Transmission. Foote Bros. Gear & Machine Co., 5301 South Western Blvd., Chicago, Ill.—Catalog 350—86-page pocket-size handbook on this company's worm gearing and worm gear speed reducers.

Power Transmission. D. O. James Mfg. Co., 1132 West Monroe St., Chicago, Ill.—Leaflet briefly describing a wide range of speed reduction equipment made by this company.

Power Transmission. Link Belt Co., 307 North Michigan Ave., Chicago, Ill.—Catalog 1725—32 pages on this company's Silver-streak silent chain drives.

Pumps. Goulds Pumps, Inc., Seneca Falls, N. Y.—Catalog Section IV—42 pages on centrifugal pumps, piston, rotary, and diaphragm pumps and foot valves, with engineering data.

Pumps. Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass.—Bulletin 207—4 pages on this company's slurry and sludge pumps.

Pumps. Lawrence Pump & Engine Co., Box 70, Lawrence, Mass.—Bulletin D-45—8 pages on this company's close-coupled centrifugal pumps.

Pumps. Morris Machine Works, Baldwinsville, N. Y.—Bulletin 156—16 pages completely describing this company's slurry and sludge pumps; also Bulletin 157, 16 pages, covering in brief fashion this company's line of centrifugal pumps, dredges and steam engines.

Pumps. Quimby Pump Co., 340 Thomas St., Newark, N. J.—Bulletin R-200—4 pages on this company's oval-rotor pumps.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: W-101—B2A, Horizontal duplex piston pumps; W-102—B2, Horizontal duplex piston pumps; W-450—B27, Deep-well turbine pumps; W-475—B10, 11, 12, Double helical rotary pumps.

Refractories. General Refractories Co., 106 South 16th St., Philadelphia, Pa.—Pamphlet on application of Ritex process to the manufacture of chrome brick.

Thiokol. Thiokol Corp., Yardville, N. J. —Leaflet describing this company's new Thiokol molding powder for producing oil-proof, rubber-like molded products.

Valves. Cooper Alloy Foundry Co., 150 Broadway, Elizabeth, N. J.—Illustrated booklet describing this company's line of stainless steel valves and fittings.

Valves. Edward Valve & Mfg. Co., East Chicago, Ind.—Catalog 11-D—15 pages on this company's angle and straightway blow-off valves.

Valves. Haynes Stellite Co., Kokomo, Ind.—Form 2879—8 pages on the use of Haynes Stellite applied to the seating surfaces of valves for use at high temperatures.

Valves. W. S. Rockwell Co., 50 Church St., New York City—Bulletins 353 and 355 —Respectively describing slide-type and butterfly-type blast gates made by this company.

Tools. Superheater Co., 60 East 42d St., New York City—Catalog 20,001-1—Describes this company's non-sparking tools.

Welding. Air Reduction Sales Co., Lincoln Bldg., New York City—52 pages on this company's products for electric welding, including electrodes, welding machines and miscellaneous apparatus.

Welding. Linde Air Products Co., 30 East 42d St., New York City—Reprint of 5-page article on repair of damaged cast-iron machinery.

Welding. Linde Air Products Co., 30 East 42d St., New York City — 10-page booklet summarizing available information on bronze welding and bronze surfacing.

Tanks. Chicago Bridge & Iron Works, 57 West Van Buren St., Chicago, Ill.—Technical Bulletin 11—24 pages on oil storage tanks with general specifications, design notes, joint efficiency and capacity tables and engineering data.

Chemical Engineering NEWS

Monsanto Chemical Acquires Thomas & Hochwalt

ANNOUNCEMENT was made on March 2 by Edgar M. Queeny, president of Monsanto Chemical Co., that contracts had been entered into which provide for acquisition by the Monsanto company of Thomas & Hochwalt Laboratories of Dayton, Ohio, and its subsidiary, Dayton Synthetic Chemicals, Inc.

Monsanto thus acquires the only outstanding minority interest in its controlled subsidiary, Monsanto Petroleum Chemicals, Inc. The latter company, which is in the research and development stage, has carried on its research work in the laboratories of Thomas & Hochwalt.

Mr. Queeny stated that this acquisition augments the Monsanto research department with a highly trained staff with varied experience and that it is planned to carry on exploratory and application research not directly connected with present manufacturing activities. The laboratories will be known as the Thomas & Hochwalt Laboratories Division of Monsanto Chemical Company, and will continue under the direction of Dr. Charles A. Thomas and Dr. Carroll A. Hochwalt.

Arrangements have been made for the gradual discontinuance of the research Thomas & Hochwalt Laboratories have been conducting for other companies, and the transfer of their sole attention to the problems of the Monsanto company.

Electrochemists Honor Hall's Memory

TWO HUNDRED representatives of science and industry gathered at the Waldorf-Astoria Hotel in New York, February 17, to do honor to Charles Martin Hall on the occasion of the 50th anniversary of his discovery of the electrolytic process of producing aluminum. Sponsored by the Electrochemical Society since aluminum was the first and is still the largest electrochemical industry, the dinner was attended by members of that society and of the American Institute of Mining and Metallurgical Engineers, members of the aluminum industry and directors of research for twenty of the most important industries of the United States. Honored guests included eight of the fifteen living Perkin medallists since the dinner not only celebrated the 50th anniversary of Hall's discovery but also the 25th anniversary of the award to him of the Perkin medal.

Dr. Francis C. Frary, past-president of the Electrochemical Society and director of the Aluminum Research Laboratories, was toastmaster. Speakers included Dr. Frederick M. Becket, president of the Union Carbide & Carbon Research Laboratories, Dr. Alexander Klemin of the Guggenheim School of Aeronautics, Homer H. Johnson, Cleveland attorney and classmate of Hall, and Arthur V. Davis, chairman of the board of the Aluminum Company of America, who gave the acknowledgment which the entire aluminum industry owes to Hall and his invention. An associate of Hall's from the beginning of his career and a co-worker with him, Mr. Davis told of the struggle in the early days of the industry and of the large investment of capital and effort necessary to bring about the metallurgical beneficiation of aluminum in order that its price could be brought from $8 per lb. down to the present figure of approximately 20 cents per lb.

Brooklyn Poly Extends Graduate Training

A SURVEY recently completed by Professor J. C. Olsen, of the Polytechnic Institute of Brooklyn, points to the existence of a very large potential demand in the New York Metropolitan area for graduate work in chemical engineering leading to both the Master's and Doctor's degrees. The survey shows that there are approximately 5,000 companies in this area engaged in manufacture or business closely connected with chemical industry. These companies may employ from 10 to 50 chemists and chemical engineers. Many of the younger men filling these positions desire to continue their education and secure advanced degrees. In some cases young men who have been educated as chemists desire to take chemical engineering courses, leading to graduate degrees in that subject.

The demand for advance study in chemical engineering was demonstrated at the Polytechnic Institute last fall by the enrollment of 37 college graduates in a course in "unit processes of organic synthesis" offered for the first time this year. This demand will tend to increase as a result of the rapid expansion of the organic chemical industry.

To meet this situation, the incorporation of the Polytechnic Institute of Brooklyn on Feb. 10 authorized a curriculum of graduate courses leading to the doctorate in chemical engineering.

New Chemical Plant for Charlotte, N. C.

WITH the formation of the Southern Chemical Corp., a new company enters the field at Charlotte, N. C., for the production and distribution of dyestuffs and chemicals for the textile trade. The new company is headed by John L. Crist as president. He formerly was southern sales manager of the Calco Chemical Co. Arthur J. Buchanan is vice-president and Leland G. Atkins, former superintendent of Mathieson Alkali Works at Saltville, Va., is superintendent.

Construction work on the new plant has been planned, having been designed by the organization which also will supervise construction. Plans call for an expenditure of $100,000 with six units to be erected for manufacturing operations and a seventh building to house the offices and laboratory. In the meantime, offices have been opened at 822 West Morehead St.

Canadian Chemical Societies Will Meet in June

AT A meeting of the Council of the Canadian Chemical Association held in Toronto in January, arrangements were made to hold the next convention of the association at the General Brock Hotel in Niagara Falls, Ontario, on June 9-11.

This convention will be a joint meeting of the Canadian Chemical Association and the Canadian Institute of Chemistry and will be under the management of the Niagara District Chemical and Industrial Association of which W. H. Macartney of St. Catharines is secretary and A. S. Townshend will act as convenor of the Convention Committee.

The Canadian Chemical Association now has a membership across Canada of seventeen hundred.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

When in an effort for the national defense, the Federal Government must generate power, then the marketing of this power by means of federally owned transmission lines is a proper Government activity within the Constitution. This is in essence the single positive decision important to business in the finding of the Supreme Court, February 17, with respect to the proposal that TVA buy from Alabama Power Company certain transmission lines. The Court certainly did not decide how much farther than this the Federal Government rightly can go. Only by inference can one read into the following material, quoted from the majority decision, some idea as to probable limitation of future Court findings.

"We know of no constitutional ground upon which the Federal Government can be denied the right to seek a wider market. We suppose that in the early days of mining in the West, if the Government had undertaken to operate a silver mine on its domain, it could have acquired the mules or horses and equipment to carry its silver to market. And the transmission lines for electric energy are but a facility for conveying to market that particular sort of property, and the acquisition of these lines raises no different constitutional question, unless in some way there is an invasion of the rights reserved to the State or to the people. . . .

"The argument is earnestly presented that the Government by virtue of its ownership of the dam and power plant could not establish a steel mill and make and sell steel products, or a factory to manufacture clothing or shoes for the public, and thus attempt to make its ownership of energy, generated at its dam, a means of carrying on competitive commercial enterprises and thus drawing to the Federal Government the conduct and management of business having no relation to the purposes for which the Federal Government was established.

The picture is eloquently drawn but we deem it to be irrelevant to the issue here.

"The Government is not using the water power at the Wilson Dam to establish any industry or business.

"It is not using the energy generated at the dam to manufacture commodities of any sort for the public.

"The question here is simply as to the acquisition of the transmission lines as a facility for the disposal of that energy."

Agro-Chemical Industry

New emphasis is to be laid on chemical processing of agricultural materials by new research planned under the Bureau of Chemistry and Soils. Virtually complete reorganization of the old projects in this field has been undertaken and about four times as much money is to be spent in the next fiscal year on farm-products investigation. Details of plans have not yet been formulated, but it is definitely known that a new soybean laboratory will be established at Urbana, Illinois, and substantial enlargement of projects is contemplated at the chemical engineering laboratories of the Bureau at Ames, Iowa. Some of the new work will deal with soybean oil, possible new plastics from the vegetable casein, and semi-works trials of methods which have been developed for mold-fermentation processes to make organic chemicals. Certain new studies on the protection and purification of cellulose are also likely.

The research projects above mentioned are probably more important to chemical process industry than any of the much more expansive and expensive plans under revitalized AAA. That alphabetic agency will now work nominally on soil-conservation plans. Actually, there is no objective essentially new in this. The modified act is all too clear as merely a plan to evade the consequences of the Supreme Court decision invalidating direct plans for crop control. Indirect plans will probably be modestly successful, because it will pay farmers to cooperate at least as long as no new court action intervenes to cut off benefit payments.

Those criticizing agricultural policies of Washington are now laying great emphasis on the fact that the farmer really gets a higher return in percentage on his money-making investment than does the business man. Each of the last 11 years the rate of return calculated on a comparable basis shows a higher percentage for farmers (using the figures of the Department of Agriculture) than is found in the average business-man's profit (calculated from tax returns). Calculated on a comparable basis farm return on money-making investment was in 1934 about 12.3 per cent with "benefits" or 8.7 per cent without "benefits" from Uncle Sam. The comparable business-man's return the same year was a *loss* of 1.3 per cent. Such facts, however, do little or nothing to stop the Congressional effort on farm relief.

Price Fixing

Perhaps the most important business legislation before Congress, not excepting taxes, is the group of bills proposing to amend the Clayton act, by further limiting business in its pricing of its commodities. This effort is all interwoven with the official desire to secure for the Federal Trade Commission more authority over "unfair or deceptive acts and practices in commerce" even though these be not unfair with respect to competition. Also involved is the new effort to make "any person in commerce" subject to Federal Trade Commission regulation to the extent that would shame the Spanish Inquisition.

If the Federal Trade Commission is given further authority as requested it would, under the proposed law, have as great a right as Congress itself to subpoena a witness, to compel him to reveal his private business affairs, and punish him, in effect, without trial. This feature of the amending law does not seem likely to be enacted, and almost certainly would be declared unconstitutional by the courts as excessive delegation of Congressional authority to an administrating body. The limitations on price adjustment are, on the other hand, quite likely of enactment.

In effect, the proposed law would forbid the scaling down of prices on commodities sold in large quantities after the fashion which is customary in all divisions of trade. The law would virtually forbid a cutting or price to big customers more than would correspond merely to the differences to the cost of sale and delivery. Originally this legislative action was an attack by independent grocery owners on the buying practices of chain stores. But the bill was drawn so broad, apparently deliberately, as to include all classes of goods. Entire rebuilding of the price structures of chemicals would seemingly be necessary if the bill were enacted as proposed. And it is certainly being seriously considered in Congress.

Ceramic Studies

Of wide interest to the chemical industry is the following quotation from the annual report of TVA: "The Authority has fostered research in the ceramics field by the establishment of a ceramics research laboratory at Norris, Tenn. One of the principal purposes of this research has been to develop increased markets for the ceramic raw materials occurring in the valley. When the laboratory was started, the general opinion of the ceramic trade

and other uses of kaolin was that the United States had little primary kaolin. The Authority ceramic laboratory has definitely proved that there is in the Valley an immense reserve of primary kaolin of very exceptional quality. With proper processing, this kaolin has all the desirable properties for ceramic and other uses. A commercially practical method of processing has been worked out by this laboratory.

"The methods of refining, together with the fundamentals determined by this laboratory, are now being tried out by two of the largest refiners in the North Carolina district. . . . A second objective of the ceramic laboratory has been to demonstrate the practicability of manufacturing in the Tennessee Valley all grades of ceramic whiteware, and particularly high-grade porcelain dinnerware, which is now entirely imported. . . . A third purpose of the ceramic research of the Authority has been to demonstrate the practicability of electric firing of ceramic ware. Previous abortive efforts along this line had convinced the ceramic industry that electric firing was not commercially practical in the United States. However, experimental work in electric firing was undertaken in this laboratory, and the experience has demonstrated that electric firing of ceramics whiteware, using the raw materials from the Valley, is commercially feasible."

Occupational Diseases

The Department of Labor would like to initiate by a large national conference a campaign for wider State protection against occupational diseases. This movement has been initiated by Secretary of Labor Perkins in a small gathering at which select representatives of trade associations, labor unions, the insurance industry, and technical government bureaus were asked to confer on plans. This first meeting had as its nominal purpose consideration of silicosis hazards. Actually, however, a much broader purpose is to be served. The Department would like to formulate a model State law covering all occupational diseases.

At the first conference it was evident from reports of trade association executives, the Bureau of Mines, and the Public Health Service, that abundant information exists on which to base further appropriate action. Industry representatives are urging, therefore, that the technical bureaus involved take steps to formulate this information into constructive, workable form, avoiding that crusading spirit and mere propaganda which too often accompanies campaigns for protection of labor. Appalling examples of racketeering in the field of occupational disease are reported, which make most important the suggestion that these matters be handled by professional workers, not by reformers.

One specific suggestion is that this work be organized under the Surgeon-General of the Public Health Service with the cooperation in the fields in which they are acquainted of the Bureau of Mines, Bureau of Standards, and Bureau of Chemistry and Soils. Cooperation, but not control, by the Labor Department would also be sought by those who advocate this plan. Chemical industries will be vitally concerned with the results developed from the later conferences promised by Secretary Perkins. Their interest is directly involved because dust, fume, and other chemical-plant hazards are likely to be included under compensable occupational disease as these plans progress.

Vegetable Oil Shortage

Genuine shortages in domestic production of vegetable oils continue to plague the oil using industries, both those in the food fields and those, like soap, in the non-edible divisions of industry. A few facts make clear why this is so important just now.

During the 5 years, 1929-1933 inclusive, the United States production of vegetable fats and oils totaled 6,516 million pounds. In 1934 the total was 5,923 and last year it was 5,001. The deficiency of production below average was, therefore, 593 and 1,515 million pounds for the two years, or approximately 2,100 million pounds for the two-year period.

Oil and fat users in the United States commonly require about 8,000 million pounds per year of these materials. Normal imports are, therefore, of the order of 1,500 million pounds. To make up the deficit in domestic production this had to be advanced materially.

There has been much loose talk about "corners" in oil, new competition, effective tariffs, and other economic questions. One does not need to go that far to understand the situation. The above facts are basic and simple. One needs to add to them only two or three more points to have a clear picture of what is going on. Among the points deserving of such consideration are—

1. Consumption of fats and oils is generally increasing, both with increase in population and with increase in business activity, escape from the depression.

2. Curtailing cotton production, curtailed the supply of cottonseed, an important source of oil. This effect came about both from intended effort of AAA and the unwanted cooperation of the weather-man who provided serious droughts for two years.

3. Killing little pigs two years and reducing the pig population in the post-drought season both curtailed supplies of hogs for slaughter, significantly reducing the supplies of lard.

4. The major new domestic source of vegetable oils has been the soybean. But increases in that crop, at an amazing rate in the last few years, has made available new oil supplies barely sufficient to take care of 5 or 10 per cent of the deficiencies. Further large increases in soybean supply cannot be expected to meet the oil situation until simultaneously we find new outlets or new uses for bean meal necessarily produced.

Museum of Science and Industry Re-Opened

OPENED again to the public on Lincoln's Birthday, the New York Museum of Science and Industry now becomes a national factor in acquainting the public with science and its applications to industry. Formerly located in the Daily News Building and free to the public, the museum has been moved to the sidewalk level of the Sixth Avenue entrance to Rockefeller Center. On the opening day about 8,000 persons paid admission to visit the new and greatly enlarged museum.

Both permanent and temporary exhibits are shown. The temporary exhibits on the opening day and which will be shown for the next two months were prepared by the General Electric Co., the Bell Telephone Laboratories, Eastman Kodak Co. and the Goodrich Rubber Co.

The museum is of the dynamic type and arranged so that the visitor may operate many of the machines and processes and see the fundamental principles demonstrated before his eyes. This type of scientific demonstration received great impetus in the Deutsches Museum in Munich opened in 1925 and also at the recent Chicago World's Fair.

Chemical Foundation Will Finance Alcohol Plant

ARRANGEMENTS were completed on Saturday, March 7, whereby the Chemical Foundation, Inc., will give financial assistance to the Bailor Manufacturing Co., Atchison, Kansas, for working capital and for the installation of equipment for the manufacture of anhydrous ethyl alcohol. This is in line with the policy of the Chemical Foundation to develop new outlets for domestic agricultural products. The alcohol will be made by a process for which the Foundation controls patents and it will be used, mixed with gasoline, to produce automotive power. Preliminary plans call for a daily output of 10,000 gal. of alcohol with a daily consumption of 4,000 bu. of corn.

CARBONIZING COAL AT LOW TEMPERATURES MAKES PROGRESS IN ENGLAND

FROM OUR LONDON CORRESPONDENT

GENERAL outlook for the chemical industry is very satisfactory relative to other industries. This trend undoubtedly will be reflected in increased earnings for companies like Staveley, B. Laporte Ltd., while the earnings of Imperial Chemical Industries Ltd., should show a slight increase.

The capital reorganization scheme of I.C.I. has now been ratified by the High Court and the re-arrangement of the capital structure will enable the balance sheet to be cleaned up to the extent of over $20,000,000, which will go a long way towards the necessary writing down of certain capital assets and particularly the Billingham nitrogen factory.

The writer was privileged to visit the new hydrogenation plant at Billingham, which was described and illustrated in *Chem. & Met.* in November, and was particularly struck by the care and thought which has been devoted to effective and automatic control to render the plant foolproof. Compared with the early days of the synthetic nitrogen industry, when everyone was wearing an anxious and worried look lest there be a breakdown or something go wrong, this hydrogenation plant indicates that the lessons accumulated at such heavy expense in high pressure synthesis have been satisfactorily learned and applied, and the Billingham plant operates seemingly without much attention or trouble, and with a very small staff having regard to the size of the undertaking. It also has the advantage of shooting into a much larger market than synthetic nitrogen had in the fertilizer industry, and it is only a matter of time before other hydrogenation plants will be considered or built in this country, and it may be that one or two other processes which are about to complete the development stage may be given a trial.

A most important feature of the new hydrogenation industry is the fact that it is a ready and profitable market for low temperature tars obtained by carbonization of British coal, and thereby a strong fillip will be given to the low temperature carbonization industry both in England and in the Colonies, particularly South Africa and Australia.

While it will never be possible in this country to manufacture the whole requirements of gasoline, there is very little doubt that the next few years will see a considerable increase in the number of plants carbonizing coal at low temperatures for the production of smokeless fuel, and gasoline. The pioneer in this field is Low Temperature Carbonisation Ltd., and they are making very satisfactory progress and earning profits; recently they introduced their gasoline to the trade under the name of Coalene and sales are very satisfactory, the balance of the low temperature tar going direct to the Billingham factory under contract. Other companies and processes in this field vary considerably both as regards prospects and merit. Reference has already been made to Coal & Allied Industries, Ltd., who recently issued a very unsatisfactory report, which was aggravated by a serious fire in the plant that meant a shut down for several weeks. As a result the shares have fallen nearly to par, and a new issue was necessary to obtain the $250,000 which the directors say is necessary to commence operation on a smaller scale than the prospectus estimate.

As regards the "valuable chemical products" on which the highest hopes were based, the directors content themselves by indicating that they still have confidence in their value. These disappointing results are likely to have far-reaching effects upon the low temperature carbonizing industry as a whole, as it will make it increasingly difficult to arrange the finance necessary for the exploitation of new processes, however meritorious. Among the newcomers is a Belgian process called the Holcobami, which is well spoken of and has been operating satisfactorily for many months on a unit scale.

Considerable interest is being shown in the recent development of the Igraf process for making parchment paper in a new way, based upon a means of impregnating the paper base under vacuum with the chemical equivalent of the horny material from which the nails and hoofs of animals are formed, viz.: material containing glutin and keratin. These parchment papers are not only satisfactory for book binding, but they can be applied for wall coverings and for plywood and Celotex, the surface being waterproof and when polished almost unscratchable.

The provisional programme of the Chemical Engineering Congress of the World Power Conference, which is to be held in London from June 22 to June 27 has just been issued.

SUPERIOR QUALITIES CLAIMED FOR SYNTHETIC RUBBER DEVELOPED IN GERMANY

FROM OUR BERLIN CORRESPONDENT

AT THE International Automobile Exposition, recently held in Berlin, an opportunity was given for exploiting the new synthetic rubber of the I.G. called "Buna." This is not the same as the rubber produced during the war years (called "Methylkautschuk") which was made by polymerizing isoprene. That production ceased after the war when supplies of natural rubber again became available. In 1926 new experimental work was encouraged by the high prices asked for natural rubber. In this experimental work lime and coal were the raw materials used to produce acetylene. The price of rubber then began to go down and in a few years was so low that the development of synthetic rubber lost any economic significance.

But enough progress had been made to prove that the manufactured had some qualities which made it superior to the natural product. Hence, further research was continued even through the period when rubber was selling at its low levels.

Without attempting to go into details, the process for producing "Buna," goes back to the earlier development of acetylene and converting it into butadiene. The latter is changed by polymerization into three forms of synthetic rubber. In the form of soft rubber, the synthetic material is said to have advantages over the natural. Among the advantages claimed are that it does not deteriorate so quickly; it is more stable to heat; tires made from it have about 30 per cent longer duration of life than those made from natural rubber. At the exposition tires were shown, made from natural and synthetic rubber and which had been run over the same mileage. Those made from natural rubber showed the greater signs of wear.

In appearance, the synthetic rubber resembles the best and purest Para sheets but it is more transparent. Its odor is like that of natural rubber with a distinct aromatic scent. Up to now, the new product has been tested by I.G. and by the Continental Caoutchouc Co. but it is now being tried out by many German tire manufacturers.

Detoxification of town-gas from carbon oxide is performed by several new methods. According to Bertelsmann-

Schuster, (Ges. für Gasentgiftung, Berlin,) steam is injected into the gas in order to produce a "water-gas-equilibrium" and by an appropriate sulphur catalyzer the carbon oxide content is reduced to 1 per cent. Experiments have shown that 0.33 per cent carbon oxide is injurious if inhaled for several hours. So the method of Kemmer (Berliner Städtische Gaswerke) seems to be preferable because the gas is almost completely purified by it. The first stage of this method corresponds to the water-gas-equilibrium and in the second stage the residual carbon oxide is removed conforming to the synthesis of methane. This latter method is more flexible. A further advantage of detoxification is the purifying of the gas of corrosion and gum formers.

Ozaphan is a new material for films produced by the Agfa (I.G.). In contrast with the celluloid film it is very difficult to ignite. The base material is cellophane impregnated with a light sensitive diazo compound. This imparts to the film a yellow color. Two advantages are gained by eliminating the silver-containing emulsion sheet: the ozaphan film is made of domestic material and is cheaper to produce because it is free from silver; secondly, the picture on this film is indestructible, i.e. it is only destroyed with the film itself, because the picture is contained in the whole cross-section of the film. Compared with other similar material the ozaphan film is very thin. According to its light-slowness it is not possible to photograph directly on ozaphan, it is only used as copy. The ozaphan film is developed and fixed by a dry method, by ammoniac vapors. In order to overcome the small light sensitivity special copy machines are used with lamps of high intensity.

According to a process suggested by Linde—A.G. and Fränkel mixtures of gases may be decomposed so that it is possible to get oxygen so cheap, that it may be applied for chemical and metallurgical purposes. Cooling accumulators (Kältespeicher) are used in the liquefaction and decomposition of the gas mixtures. The accumulators are filled with corrugated bands of iron or aluminum spirally wound up, that give a cooling area of more than 1,000 sq.m. per cu.m. From the air, mixtures of oxygen and azote may be gotten with a content of 42 to 95 per cent oxygen.

The Metallgesellschaft, Frankfort/Main, has developed a process to gain sulphuric acid from hydrogen sulphide, in particular from the gases developed in the distillation of coal and lignites, from natural gas and from hydrogenation of petroleum products. The gases are burned with air in surplus. The resulting gases are conducted over a contact in order to oxidize dioxide to trioxide of sulphur; the resulting gases are then condensed by fractionation. The furnace is held at 750° to 800°C. Organic contaminations of the gas do not disturb the process because they are burned. If the gas is poor in H_2S combustion is difficult. In such cases the oven is completed by a lattice-work of chamotte, on the hot surface of which the H_2S is burned without difficulty. The burning gases are introduced into the contact chamber at 400° C. The contact vessel is warmed in the beginning of the reaction and cooled during the reaction by a jacket. Theoretically the temperature of the SO_2, that comes in the contact chamber with 400° rises about 150° by the reaction so that the gases attain 550°. At this temperature SO_3 begins to decompose to $SO_2 + O$. Therefore the reaction heat must be led away. A contact on the base stannic oxide-chromic oxide is appropriate for the catalytic oxidation of SO_2 but is influenced by steam therefore a vanadium catalyzer was chosen, which is not sensitive to steam.

The yield of this process attains 98 per cent and more in plant practice. By regulating the temperature the condensation may be performed in fractions, so that the water content of the supplied SO_2 has almost no influence on the strength of the recovered acid. In general the process yields a very pure, water white acid of 86-90 per cent H_2SO_4. In practice a plant at the Frankfort gas works (since 1933) gives daily 1 ton of monohydrate. Another plant at a Ruhr coking plant gives a daily production of approximately 6 tons of acid of 60° Bé.

CALENDAR

International Chemical Engineering Congress, London, England, June 22-27.

American Ceramic Society, annual meeting, Columbus, Ohio, Mar. 29-Apr. 4.

American Chemical Society, Kansas City, Apr. 13-17.

Electrochemical Society, annual meeting, Cincinnati, Apr. 23-25.

American Petroleum Institute, mid-year meeting, Tulsa, Okla., May 13-15.

American Society for Testing Materials, annual meeting, Atlantic City, June 29-July 3.

American Leather Chemists Association, Skytop, Pa., June 10-12.

Technical Association of the Pulp & Paper Industry, Montreal, Aug. 3-6.

National Metal Congress and Exposition, Cleveland, Oct. 19-23.

Du Pont Finances Research Fellowships

WITH an increasing demand for research chemists and wishing to encourage more promising students in research work in the field of chemistry, E. I. du Pont de Nemours & Co. has again appropriated funds to permit establishing fellowships in twelve leading universities and colleges for the academic year 1936-1937.

The appropriation for the resumption of these fellowships is $18,000, half of which is to cover the cost of continuing for the academic year 1936-1937 four post-doctorate fellowships in organic chemistry at $2,000 each, plus an additional $1,000 to cover the cost of extraordinary equipment that may be required in connection with the work of this group. The remaining $9,000 is to cover the cost of re-establishing twelve post-graduate fellowships at $750 each.

The twelve universities selected are as follows: For chemistry—University of Chicago, Cornell, Harvard, Johns Hopkins, Ohio State, Princeton, Yale, Illinois, Minnesota, Wisconsin. For chemistry or chemical engineering—University of Michigan and Massachusetts Institute of Technology.

Annual Priestley Lectures at Penn State

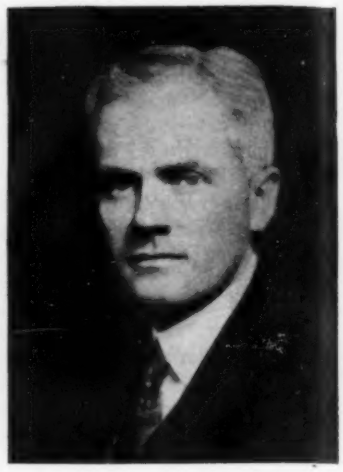
THE tenth annual Priestley lecturer at Pennsylvania State College will be Dr. W. K. Lewis, professor of chemical engineering at Massachusetts Institute of Technology. The lectures will deal with the inter-relationships between physical chemistry and chemical engineering, and will be given in the Chemistry Ampitheatre, March 23-27.

Professor Lewis, Perkin Medallist for 1936, and one of the founders of modern chemical engineering, has chosen for his topic, "The Borderline Between the Physical Chemistry of Fluids and the Behavior of Suspensions." The five lectures will deal with The Structure of Liquids, Viscosity of Fluids, Suspensions and Emulsions, and Gelation.

The Priestley lecture series was inaugurated by the faculty of the Department of Chemistry in 1926 as a memorial to Joseph Priestley, discoverer of oxygen, whose American laboratory was situated only a few miles from State College. In 1931 the Penn State Chapter of Phi Lambda Upsilon undertook the financial support of the lecture series. These lectures, therefore, now constitute a joint memorial to Joseph Priestley on the part of both the faculty of the Department of Chemistry and of the Penn State Chapter of Phi Lambda Upsilon.

Kenneth S. Valentine

C. S. Boruff



Paul D. Merica

PERSONALITIES

KENNETH S. VALENTINE has been appointed district manager at New York of the Patterson Foundry & Machine Co. He had previously served the Turbo Mixer Corp. as sales manager, Heller & Merz Co. as chemical engineer, and the Southern Dyestuffs Co., as works manager.

WILBERT J. HUFF of the engineering faculty, Johns Hopkins University, has been appointed chief chemist of the explosives division of the Bureau of Mines.

THEODORE M. SWITZ has joined Pulp Products Co., manufacturers of seamless pulp containers, in the capacity of technical director. He resigned from the Barrett Co. where he had been in charge of market research to accept this position with the Massillon, Ohio, organization.

GEORGE P. HALLIWELL, formerly assistant professor of metallurgy at Carnegie Institute of Technology, has been appointed director of research at H. Kramer & Co., Chicago.

CLINTON E. STRYKER is now associated with McKinsey, Wellington & Co., Chicago. He was formerly chief engineer of Fansteel Metallurgical Corp. and Vascoloy-Ramet Corp. of North Chicago.

THORNE L. WHEELER has been elected vice-president of Arthur D. Little, Inc., Cambridge, Mass.

C. S. BORUFF, since 1934 connected with Hiram Walker & Sons, Inc., Peoria, Ill., has been made technical director, according to announcement of H. F. Willkie, vice-president. As a graduate student at the University of Illinois, Dr. Boruff became interested in biological chemistry as applied to fermentology, after which he practiced as a consultant.

HARRY A. NOYES has joined the staff of Arthur D. Little, Inc., Cambridge, Mass. He had previously been connected with the Applied Sugar Laboratories, Foods, Inc., Texas Gulf Sulphur Co., New Rochelle Research Laboratories, Welch Grape Juice Co., Mellon Institute, and others.

M. W. LINK will be head of the newly organized division of research and development of Crane Co. His assistant will be B. A. Parks.

WALTER M. FUCHS, European fuel technologist, has recently become research associate professor in fuel technology at Pennsylvania State College. He has been a member of the faculty of the University of Brünn, the Kaiser Wilhelm Institut für Kohlen-forschung and the University of Aachen.

E. E. LITKENHOUS, research chemical engineer with the Goodyear Tire and Rubber Co., Akron, has been appointed assistant professor of chemical engineering at the University of Louisville.

PAUL D. MERICA, formerly assistant to the president, has been made vice-president of the International Nickel Co. Mr. Merica came to the company in 1919 from the Bureau of Standards where he had been metallurgist. For many years as director of research, he had general supervision over the development of the company's research laboratories in England and the United States.

F. M. SHIPMAN, professor of chemical engineering at the University of Louisville, has resigned to become technical director of the Brown Forman Distillers, Louisville.

W. M. LOFTON, JR., has been appointed chief chemist in charge of the laboratories at the plant of the Pennsylvania Coal Products Co., Petrolia.

DR. H. B. MANN, agronomist in soil fertility at North Carolina State College of Agriculture, has joined the staff of the American Potash Institute. He will serve as assistant manager of the southern territory of the Institute.

LEMUEL M. AYCOCK has joined the American Agricultural Chemical Co. He is located in New York.

HARRY L. MILLER, formerly vice-president and technical director of the Quaker Chemical Products Corp. at Conshohocken, Pa., has resigned his position with that company to form the Haas-Miller Corp., Philadelphia, Pa.

Andrew E. Buchanan

ANDREW E. BUCHANAN has accepted the position of research director of the Remington Arms Co. His headquarters will be at Bridgeport, Conn. Mr. Buchanan after graduating from the chemical engineering department of Lehigh University was employed by the E. I. duPont de Nemours & Co. In 1922 he joined the editorial staff of *Chemical & Metallurgical Engineering.* For the past eight years he has served as secretary of the Alumni Association of his alma mater.

LEO RUTSTEIN has resigned from the firm of Worden Laboratory and Library, Millburn, N. J., and will organize and head Rutstein Laboratory and Library, Newark, N. J.

THOMAS S. GRASSELLI, president of the Grasselli Chemical Co., has been elected a vice-president of the E. I. duPont de Nemours & Co.

OBITUARY

HUGO LIEBER died January 3. He was the first president of the Compressed Gas Manufacturers' Association and served in that position for ten years. In recognition of his services to the Association he was made an honorary member.

MORRIS R. POUCHER, president of the National Fuels Corp., an affiliate of American Cyanamid Co., died unexpectedly February 11 at his office in New York. He was 77 years of age.

IRVING W. FAY died February 10 at his home in Brooklyn, N. Y., after a long illness. He was 74 years old. Professor Fay, a native of Massachusetts, had attended Harvard University, Heidelberg University and the University of Berlin. He had been on the faculty of Brooklyn Polytechnic Institute for over 35 years.

ALBERT HUNTINGTON HOOKER died of pneumonia March 9 at the age of 70 at his home in Lewiston, N. Y. He was born in Rochester, N. Y., and educated at the University of Rochester and Massachusetts Institute of Technology. Mr. Hooker had been an executive of the Hooker Electro Chemical Co. for over 30 years.

WILLIAM J. CUMMINS died unexpectedly in a Chicago hotel, February 24. He was 74 years of age.

Mr. Cummins was born in Paris, Tenn., and conducted a brokerage business in Nashville for many years before going to New York. He purchased the Bon Air Coal & Iron Co. of Nashville and became vice-president and general manager. Later this organization, the Bon Air Chemical Co. and the Chattanooga Coke & Gas Co. were combined to form the Tennessee Products Corp. At the time of his death Mr. Cummins was chairman of the board of this combine.

WILLIAM GILBERT MIXTER, for many years a member of the Yale University faculty, died March 9 at his home in New Haven. He was 89 years old.

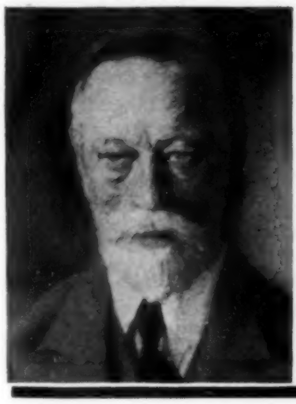
CLAUDE HARTFORD died at his home in Maplewood, N. J., February 4. He was 50 years of age. For many years he was associated with the New York Steam Co.

CHRISTIAN BREVOORT ZABRISKIE, formerly vice-president of the Pacific Coast Borax Co., died February 8 of septicaemia in a hospital at Port Jefferson, New York. He was 71 years old. Mr. Zabriskie first became interested in the borax industry in 1885 when he was employed by the company as purchasing agent. He retired in 1933, because of ill health.

C. O. NORTH died February 6 as the result of an explosion at the plant of Ohio-Apex, Inc., Nitro, W. Va. After graduating from Carnegie Institute of Technology he became associated successively with the Republic Rubber Co., the Goodyear Tire & Rubber Co., and the Republic Service Laboratories Co. He was also connected with the Elko Chemical Co. Seven years ago he organized and was president of Kavalco Products, Inc. with a plant at Nitro. This company was succeeded in 1934 by the Apex Chemical Co. of Ohio, which changed its name about a year ago to Apex-Ohio, Inc.

GEORGE D. ROSENGARTEN died February 24 in his apartment at Philadelphia after an illness of about two years. He was in his sixty-eighth year. Dr. Rosengarten had been vice-president of Rosengarten & Sons, Inc., and its successor, Powers, Weightman-Rosengarten Co.; he retired in 1927. He had been honored with the presidencies of both the American Institute of Chemical Engineers and the American Chemical Society.

A. H. Hooker



William J. Cummins

C. O. North

G. D. Rosengarten

Chemical ECONOMICS

ACCORDING to the Federal Reserve Board, the adjusted index for industrial production stood at 104 for January operations. Total volume of industrial production increased in January, but, owing to a decline in activity in the automobile and allied industries from an exceptionally high level in December, the increase was less than is usual at this season, the board reported.

The unseasonal expansion in the automobile industry during December, due to the introduction of new models in November for the first time, was responsible in large part for the index reaching 104 per cent of the 1923-25 average during December, highest figure recorded since May, 1930. Recession in the automobile output during January, likewise, carried the adjusted index down with it despite gains in other industrial lines.

Shrinkage in automobile production continued during the first three weeks of February, the board reported, while the output of steel in February showed a smaller than usual gain over the January production. Textile mills and shoe factories reported increases in activity during January, but the gains were smaller than is normal for the month. Mines showed a seasonal increase in the output of coal.

Compared with January 1935, however, it is found that industrial operations in the first month of this year were on a higher level. The index number for January 1935 was 90 while for January 1936 it was 99.

So far as some of the chemical-consuming industries are concerned, activities in January were speeded up over those for the preceding month. This held true for production of plate glass, glass containers, explosives, and for textile consumption of cotton. Only a slight falling off was reported for byproduct coke and for rubber reclaiming.

Again comparing manufacturing activities for January with those for the comparable month of last year, the conclusion is drawn that production and consumption of chemicals and related products opened the present year on a higher plane than was the case a year ago. Statistics already available for January give production of ethyl alcohol as 13,179 thousand proof gal., or an increase of more than 7 per cent; denatured alcohol at 6,207 thousand proof gal., or an increase of more than 2½ per cent; byproduct coke, 3,309 thousand tons, a gain of more than 18 per cent; plate glass production of 17,276 thousand cu.ft. not only outstripped the output of 16,112 thousand cu.ft. of December but was nearly 30 per cent ahead of that for January, 1935; January production of glass containers was 3,114 thousand gross or an increase of more than 6 per cent; consumption of cotton was 591 thousand bales or a gain of more than 7 per cent. While automotive production fell below the December total, the January figure of 367,252 units represented a rise of more than 25 per cent over the total for January, 1935.

Larger Fertilizer Sales

Fertilizer tax tag sales in 12 Southern States, as reported to The National Fertilizer Association by state officials, totaled 341,793 tons, representing a gain of 6 per cent over January, 1935. Six of the reporting States registered increases over last year, with the most important rise taking place in Georgia, and declines occurred in six States. In the past five years January accounted, on the average, for 8.1 per cent of the year's sales.

During the first seven months of the current fiscal year, from July through January, sales in the South reached the highest total for the period since 1929-1930, exceeding the corresponding period of the preceding year by 7 per cent. The only two States to report declines were South Carolina and Oklahoma, and in these cases the losses were small.

Reflecting the effect of extremely cold weather and uncertainties in connection with the agricultural adjustment program, fertilizer tax tag sales in February were somewhat under February, 1935, but were well above the corresponding month of other recent years. According to reports by state officials, sales in the 17 reporting States totaled 572,514 tons for the month, compared with 748,069 tons in February, 1935; 533,146 tons in February, 1934; and 312,142 tons in February, 1933.

February sales in the 12 Southern States amounted to 546,724 tons, representing a decline of 22 per cent from the preceding year but gains of 9 per cent and 85 per cent over 1934 and 1933 respectively.

At coking plants, tar recovered amounted to 43,933,032 gal., as compared with 44,648,419 gal. in December and 37,415,792 gal. in January, 1935. Light oil recovery amounted to 13,818,415 gal., as compared with 14,065,540 gal. and 11,768,524 gal. in the same month a year ago. Ammonia sulphate, or its equivalent, amounted to 52,420 tons, as against 52,965 tons in December and 42,787 tons in January a year ago. Benzol production, estimated from the production of coke at byproduct ovens known to recover this commodity, was placed at 7,825,000 gal. which compares with 8,084,000 gal. in December and 6,182,000 gal. in January, 1935.

Labor troubles have had some effect in cutting down consumption of raw materials in the rubber trade but trade estimates are to the effect that February consumption of crude rubber did not suffer materially. It also was reported that February deliveries of carbon gas black to the rubber trade went forward in large volume with total shipments from producing points estimated at approximately 7 per cent larger than in February, 1935.

During 1935 it is estimated that at least 303,900,000 lb. of scoured wool were consumed, the heaviest consumption for any year since 1923 when the annual total was 311,300,000 lb., according to the National Association of Wool Manufacturers.

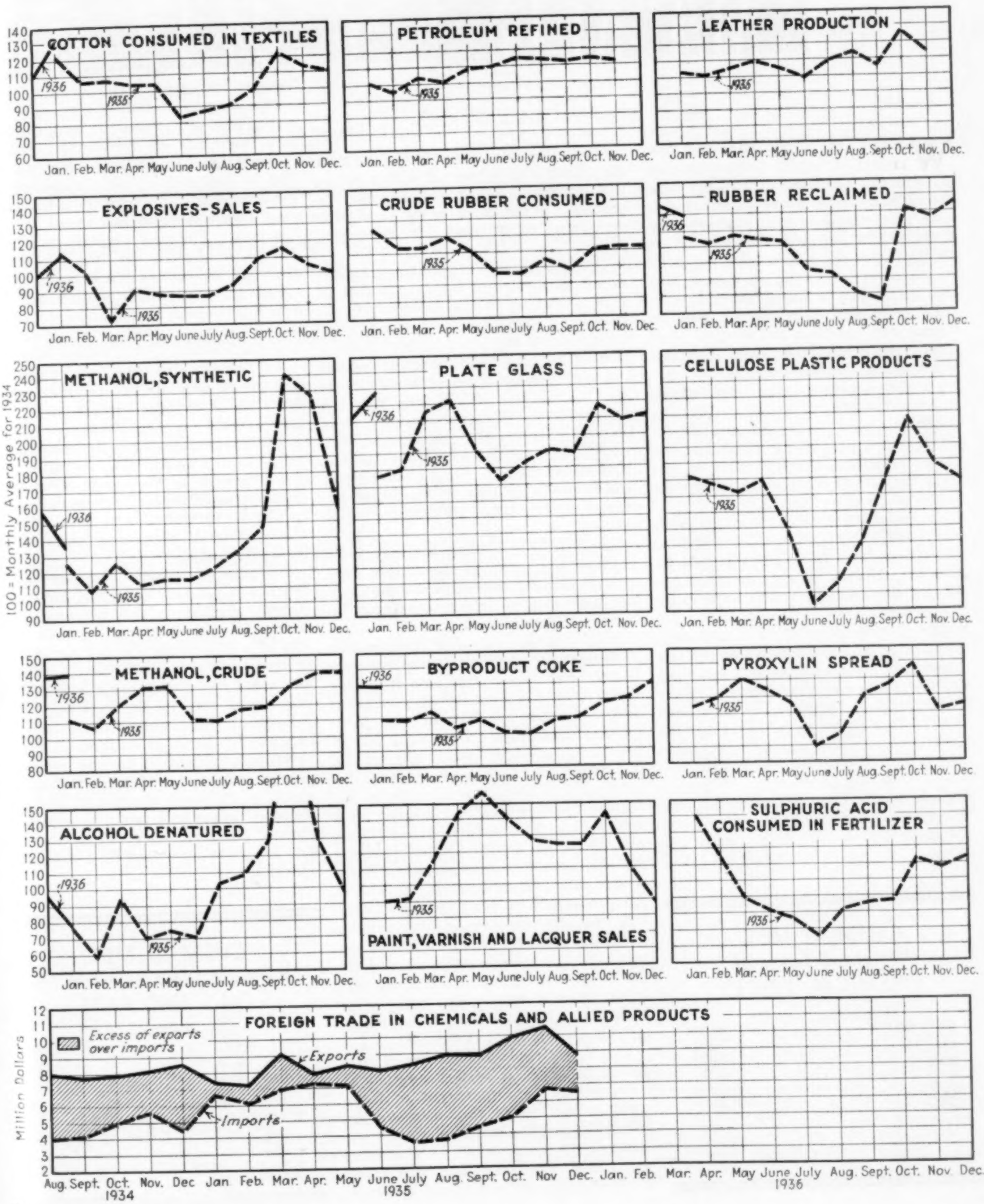
This high rate of consumption of apparel wools resulted in an unprecedented condition in the Boston market during January, the association reported. The available supply of domestic wools was so limited that sales of these were made at prices higher than foreign parity.

Consumption of wool in January was given at 73,908,000 lb. which compares with 73,367,000 lb. for December and 58,370,000 lb. for January, 1935.

Production of compounds and other lard substitutes, in which cottonseed oil is a principal base, in 1935 amounted to 1,536,921,000 lb., an increase of 386,244,000 lb. over 1934, and 584,000,000 over 1933. Also hydrogenated oils, another channel of cottonseed oil, and which are used in compounds and shortenings, reached 748,390,732 lb. in 1935, or 196,908,000 over 1934 and 259,515,000 over 1933. Oleomargarine production, which contained 26 per cent of cottonseed oil, increased 117,000,000 lb. over 1934. Margarine and "compounds and other lard substitutes" together increased 503,000,000 lb. over 1934 production.

January output of methanol was 477,946 gal. crude, 1,418,863 gal. synthetic.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

WHILE conditions have not been entirely favorable for consumption of chemicals since the turn of the year, the industry as a whole is reported to have gone ahead in a satisfactory way. Both production and consumption of chemicals for the year to date appear to compare very favorably in volume with that for the like period of last year.

Labor troubles have exerted some influence and one large mid-western plant is reported to have been closed. Consuming demand for raw materials in some cases also is said to have been reduced as a result of labor dissensions. Weather conditions, likewise are given credit for some delays in making shipments but these conditions merely tended to cut down the rate of increase made over the first two month of last year.

Prices for chemicals and related products have shown no decided trend as fluctuations have taken place in both directions. On the up side the most important changes occurred in an advance of one dollar a ton in the quotations for nitrate of soda and sulphate of ammonia. As an offset to this, an easy tone has run through the market for solvents including alcohols, acetone, ethyl acetate, and spirits of turpentine. Naval stores have been affected by a report to the effect that the Commodity Credit Corporation was planning to liquidate some of its holdings on which loans had been made. While no wholesale unloading is anticipated, the fact that additional sales pressure was imminent had a disquieting effect on values.

CHEM. & MET.
Weighted Index of
CHEMICAL PRICES

Base = 100 for 1927

This month	87.15
Last month	87.21
March, 1935	87.63
March, 1934	88.86

A slight lowering in the weighted number for the month was due principally to weakness in solvents with spirits of turpentine on a downward trend. Fertilizer chemicals, notably nitrate of soda and sulphate of ammonia were higher in price.

One of the interesting developments of the month was connected with a report that corn and other grains would be processed in the West for the production of alcohol to be used for automotive power.

The 1935 tung oil crop of China is estimated 10 to 15 per cent above that of 1934, according to Commissioner O. L. Dawson in China. Arrivals of new crop oil at Chinese markets have been heavier than normal as a result of active demand and high prices. Chinese wood oil exports during the 1935-36 crop year are expected to be 10 per cent above those for 1934-35 when they amounted to 147,467,000 lb. compared with 154,800,000 lb. in 1933-34. Exports to the United States last season amounted to 99,070,000 lb. compared with 101,733,000 lb. the previous year.

Linseed oil is holding a steady price position due partly to the smaller crop produced in the Argentine and partly to the large demand which is expected to arise in the near future.

Following an extended investigation of the uses to which blackstrap molasses is put after importation, the Treasury Department has amended customs regulations for the handling of such shipments claimed under Paragraph 502 of the tariff at three-hundredths of 1c. per pound duty "when not intended for extraction of the sugar therein or for human consumption." Hereafter that term will include, in addition to molasses used in animal feed and other products not for human consumption, molasses which after importation is utilized in the production of yeast, vinegar, alcohol, rum, gin, whiskey or other articles in which molasses or sugar do not appear. It will exclude molasses used for the extraction of sugar, for table purposes or as a sweetening, coloring or flavoring agent in the production of articles for human consumption.

The scarcity of naphthalene in producing countries is further attested by a report to the Department of Commerce which stated that domestic demand for naphthalene in Germany has increased to the point where a national shortage is threatened, and as a result the Reich Government issued a decree, prohibiting exportation of crude naphthalene. Refined naphthalene, however, may still be exported under certain circumstances, subject to specific official authorization in each instance. In former years Germany produced more naphthalene than could be consumed in the domestic market and considerable quantities were exported, particularly to the United States which took from one-half to two-thirds of the total amount exported. During the first eleven months of 1935 a total of 4,934 metric tons of naphthalene were shipped from Germany to the United States.

Neutrality legislation materialized, just as expected, in mere extension of the President's authority for a bit more than a year to embargo exports to belligerents. The new regulations immediately announced by the President continue the commodities under embargo previously with the addition of a few armament items and two additional toxic gases, neither commercially important in the United States trade.

Another act also approved during the past month provides that tin-plate scrap may not be exported except under license issued by the President. This nominally provides against depletion of the U. S. reserves of tin. Actually, the major benefit is to protect American detinning enterprises which were threatened with extermination as their sources of raw material were being monopolized by the Japanese.

No other important developments on deficiency minerals or metals have occurred officially. The National Resources Board is struggling with the idea of a new mineral policy committee to supplant the national Planning Committee for Mineral Policy abolished the first of the year by the President.

Evidently little more progress can be expected in early completion of trade agreements important to the chemical process industries. Most of the agreements which stand any chance of completion soon are with minor countries in Central America where tropical products are more important than industrial materials.

CHEM. & MET.
Weighted Index of Prices for
OILS AND FATS

Base = 100 for 1927

This month	85.48
Last month	91.29
March, 1935	99.02
March, 1934	56.30

With the exception of China wood, practically all the vegetable oils sold at lower prices during the past month although very little change was reported for linseed oil. Animal fats also were lower with tallow leading the decline.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to March 13.

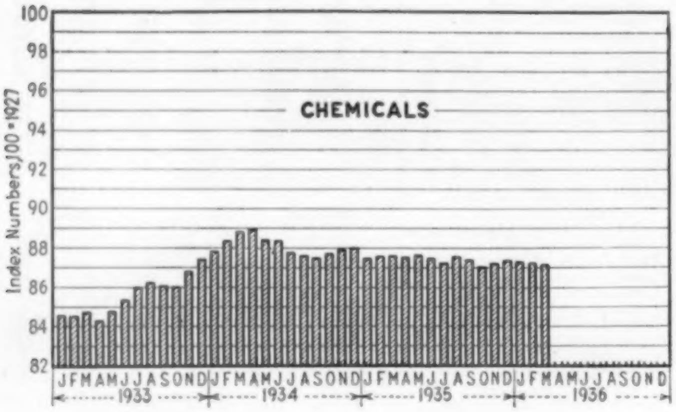
Industrial Chemicals

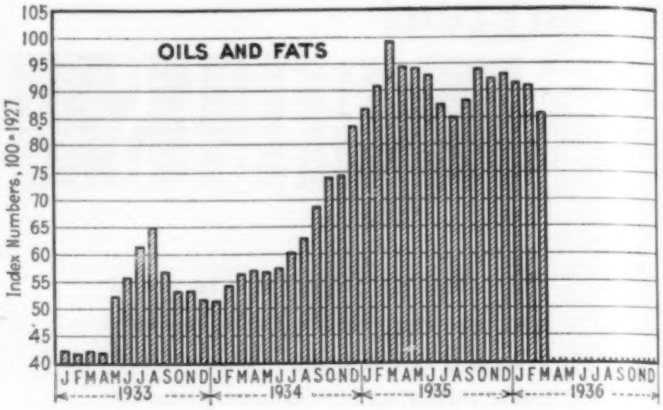
	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.10½-$0.11	$0.12 -$0.12½	$0.12 -$0.12½
Acid, acetic, 28%, bbl., cwt	2.45 - 2.70	2.45 - 2.70	2.40 - 2.55
Glacial 99%, drums	8.43 - 8.68	8.43 - 8.68	8.25 - 8.50
U. S. P. reagent	10.52 -10.77	10.52 -10.77	10.52 -10.77
Boric, bbl., ton	105.00-115.00	105.00-115.00	95.00 -105.00
Citric, kegs, lb	.28 - .31	.28 - .31	.28 - .31
Formic, bbl., ton	.11 - .11½	.11 - .11½	.11 - .11½
Gallic, tech., bbl., lb	.60 - .65	.60 - .65	.60 - .65
Hydrofluoric 30% carb., lb	.07 - .07½	.07 - .07½	.07 - .07½
Lactic, 44%, tech., light, bbl., lb	.11½- .12	.11½- .12	.12 - .12½
22%, tech., light, bbl., lb	.06½- .07	.06½- .07	.06½- .07
Muriatic, 18°, tanks, cwt	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -......	18.50 -20.00
Oxalic, crystals, bbl., lb	.11¾- .12⅛	.11¾- .12⅛	.11¾- .12⅛
Phosphoric, tech., c'bys., lb	.09 - .10	.09 - .10	.09 - .10
Sulphuric, 60°, tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Sulphuric, 66°, tanks, ton	15.50 -......	15.50 -......	15.50 -......
Tannic, tech., bbl., lb	.23 - .35	.23 - .35	.23 - .35
Tartaric, powd., bbl., lb	.24 - .25	.24 - .25	.24 - .25
Tungstic, bbl., lb	1.50 - 1.60	1.50 - 1.60	1.40 - 1.50
Alcohol, Amyl	......-......	......-......	......-......
From Pentane, tanks, lb	.15 -......	.15 -......	.143-......
Alcohol, Butyl, tanks, lb	.11 -......	.11 -......	.12 -......
Alcohol, Ethyl, 190 p'f., bbl., gal	4.27½-......	4.27½-......	4.15½-......
Denatured, 190 proof No. 1 special, dr., gal	.34 -......	.34 -......	.346-......
Alum, ammonia, lump, bbl., lb	.03 - .04	.03 - .04	.03 - .04
Chrome, bbl., lb	.04½- .05	.04½- .05	.04½- .05
Potash, lump, bbl., lb	.03¾- .04	.03 - .04	.03 - .04
Aluminum sulphate, com., bags cwt	1.35 - 1.50	1.35 - 1.50	1.35 - 1.50
Iron free, bg., cwt	2.00 - 2.25	2.00 - 2.25	1.90 - 2.00
Aqua ammonia, 26°, drums, lb	.02½- .03	.02½- .03	.02½- .03
tanks, lb	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb	.15½- .16	.15½- .16	.15½- .16
tanks, lb	.04½-......	.04½-......	.04½-......
Ammonium carbonate, powd. tech., casks, lb	.08 - .12	.08 - .12	.08 - .12
Sulphate, wks., cwt	1.25 -......	1.20 -......	1.20 -......
Amylacetate tech., tanks, lb	.12 - .135	.12 - .135	.142-......
Antimony Oxide, bbl., lb	.13½- .14	.13½- .14	.10½- .12
Arsenic, white, powd., bbl., lb	.03½- .04	.03½- .04	.03½- .04
Red, powd., kegs, lb	.15¾- .16	.15¾- .16	.15¾- .16
Barium carbonate, bbl., ton	56.50 -58.00	56.50 -58.00	56.50 -58.00
Chloride, bbl., ton	72.00 -74.00	72.00 -74.00	74.00 -75.00
Nitrate, cask, lb	.08½- .09	.08½- .09	.08½- .09
Blanc fixe, dry, bbl., lb	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt	2.00 - 2.10	2.00 - 2.10	1.90 - 2.00
Borax, gran., bags, ton	44.00 -49.00	44.00 -49.00	40.00 -45.00
Bromine, cs., lb	.36 - .38	.36 - .38	.36 - .38
Calcium acetate, bags	2.10 -......	2.10 -......	2.00 -......
Arsenate, dr., lb	.06 - .07	.06 - .07	.06 - .07
Carbide drums, lb	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., del., ton	20.00 -33.00	20.00 -33.00	20.00 -33.00
flake, dr., del., ton	22.00 -35.00	22.00 -35.00	22.00 -35.00
Phosphate, bbl., lb	.07½- .08	.07½- .08	.07½- .08
Carbon bisulphide, drums, lb	.05½- .06	.05½- .06	.05½- .06
Tetrachloride drums, lb	.05¼- .08½	.05¼- .06	.05¼- .06
Chlorine, liquid, tanks, wks., lb	2.15 -......	2.15 -......	2.00-......
Cylinders	.05½- .06	.05½- .06	.05½- .06
Cobalt oxide, cans, lb	1.29 - 1.35	1.29 - 1.35	1.25 - 1.35
Copperas, bgs., f.o.b., wks., ton	15.00 -16.00	15.00 -16.00	14.00 -15.00
Copper carbonate, bbl., lb	.08¾- .16	.08¾- .16	.08¾- .16
Cyanide, tech., bbl., lb	.37 - .38	.37 - .38	.37 - .38
Sulphate, bbl., cwt	3.85 - 4.00	3.85 - 4.00	3.85 - 4.00
Cream of tartar, bbl., lb	.16¾- .17	.16¾- .17	.16¾- .17
Diethylene glycol, dr., lb	.16½- .20½	.16½- .20½	.14 - .16
Epsom salt, dom., tech., bbl., cwt	1.80 - 2.00	1.80 - 2.00	2.10 - 2.15
Imp., tech., bags, cwt	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Ethyl acetate, drums, lb	.07½-......	.08½-......	.08½-......
Formaldehyde, 40%, bbl., lb	.06 - .07	.06 - .07	.06 - .07
Furfural, dr., contact, lb	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, ref. drums, lb	.16 - .18	.16 - .18	.16 - .18
Glaubers salt, bags, cwt	.85 - 1.00	.85 - 1.00	1.00 - 1.10
Glycerine, c.p., drums, extra, lb	.14 - .14½	.14 - .14½	.14 - .14½
Lead:			
White, basic carbonate, dry casks, lb	.06½-......	.06½-......	.06½-......
White, basic sulphate, sck., lb	.06 -......	.06 -......	.06 -......
Red, dry, sck., lb	.07 -......	.07 -......	.06 -......
Lead acetate, white crys., bbl., lb	.10½- .11	.10½- .11	.10½- .11
Lead arsenate, powd., bbl., lb	.09 - .10	.09 - .10	.09 - .10
Lime, chem., bulk, ton	8.50 -......	8.50 -......	8.50 -......
Litharge, pwd., csk., lb	.06 -......	.06 -......	.05 -......
Lithophone, bags, lb	.04½- .05	.04½- .05	.04½- .05
Magnesium carb., tech., bags, lb	.06 - .06¼	.06 - .06¼	.06 - .06¼
Methanol, 95%, tanks, gal	.33 -......	.33 -......	.33 -......
97%, tanks, gal	.34 -......	.34 -......	.34 -......
Synthetic, tanks, gal	.35½-......	.35½-......	.35½-......
Nickel salt, double, bbl., lb	13. - .13½	.13 - .13½	.12½- .13
Orange mineral, csk., lb	.10 -......	.10 -......	.09 -......
Phosphorus, red, cases, lb	.44 - .45	.44 - .45	.44 - .45
Yellow, cases, lb	.28 - .32	.28 - .32	.28 - .32
Potassium bichromate, casks, lb	.08½- .09	.08½- .09	.07¾- .08¼
Carbonate, 80-85%, calc. csk., lb	.07 - .07½	.07 - .07½	.07 - .07¼
Chlorate, powd., lb	.08 - .08½	.08 - .08½	.09½- .10
Hydroxide(c'stic potash) dr., lb	.06¼- .06½	.06¼- .06½	.06½- .06¾
Muriate, 80% bgs., ton	23.00 -......	23.00 -......	22.00 -......
Nitrate, bbl., lb	.05½- .06	.05½- .06	.05½- .06
Permanganate, drums, lb	.18½- .19	.18½- .19	.18½- .19
Prussiate, yellow, casks, lb	.18 - .19	.18 - .19	.18 - .19
Sal ammoniac, white, casks, lb	.04½- .05	.04½- .05	.04½- .05
Salsoda, bbl., cwt	1.00 - 1.05	1.00 - 1.05	1.00 - 1.05
Salt cake, bulk, ton	13.00 -15.00	13.00 -15.00	13.00 -15.00
Soda ash, light, 58%, bags, contract, cwt	1.23 -......	1.23 -......	1.23 -......
Dense, bags, cwt	1.25 -......	1.25 -......	1.25 -......
Soda, caustic, 76%, solid, drums, contract, cwt	2.60 - 3.00	2.60 - 3.00	2.60 - 3.00
Acetate, works, bbl., lb	.04¾- .05	.04¾- .05	.04½- .05
Bicarbonate, bbl., cwt	1.85 - 2.00	1.85 - 2.00	1.85 - 2.00
Bichromate, casks, lb	.06½- .07	.06½- .07	.05¾- .06⅛
Bisulphate, bulk, ton	15.00 -16.00	15.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb	.03¾- .04	.03¾- .04	.03 - .04
Chlorate, kegs, lb	.06¼- .06½	.06¼- .06½	.06¼- .06½
Chloride, tech., ton	12.00 -14.75	12.06 -14.75	12.00 -14.75
Cyanide, cases, dom., lb	.15½- .16	.15½- .16	.15½- .16
Fluoride, bbl., lb	.07½- .08	.07½- .08	.07½- .08
Hyposulphite, bbl., lb	2.40 - 2.50	2.40 - 2.50	2.40 2.50
Metasilicate, bbl., cwt	2.90 - 3.00	2.90 - 3.00	3.25 - 3.40
Nitrate, bags, cwt	1.325-......	1.275-......	1.24 -......
Nitrite, casks, lb	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb	.022- .023	.022- .023	.022- .024
Prussiate, yel. drums, lb	.11½- .12	.11½- .12	.11½- .12
Silicate (40° dr.) wks., cwt	.80 - .85	.80 - .85	.80 - .85
Sulphide, fused, 60-62%, dr., lb	.02¾- .03½	.02¾- .03	.02¾- .03
Sulphite, cyrs., bbl., lb	.02¼- .02½	.02¼- .02½	.02¼- .02½
Sulphur, crude at mine, bulk, ton	18.00 -......	18.00 -......	18.00 -......
Chloride, dr., lb	.03½- .04	.03½- .04	.03½- .04
Dioxide, cyl, lb	.06½- .08	.06½- .08	.07 - .07½
Flour, bag, cwt	1.60 - 3.00	1.60 - 3.00	1.60 - 3.00
Tin Oxide, bbl., lb	.51 -......	.51 -......	.52 -......
Crystals, bbl., lb	.37 -......	.37 -......	.36 -......
Zinc chloride, gran., bbl., lb	.05 - .06	.05 - .06	.05½- .06
Carbonate, bbl., lb	.09 - .11	.09 - .11	.09½- .11
Cyanide, dr., lb	.36 - .38	.36 - .38	.38 - .42
Dust, bbl., lb	.069- .07	.069- .07	.057- .07
Zinc oxide, lead free, bag, lb	.05 -......	.05 -......	.05¾-......
5% lead sulphate, bags, lb	.04½-......	.04½-......	.05½-......
Sulphate, bbl., cwt	2.65 - 3.00	2.65 - 3.00	2.75 - 3.00

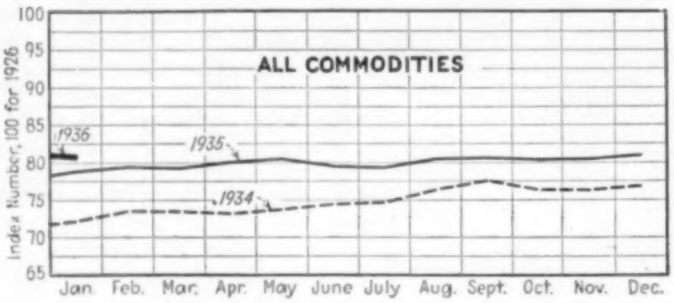
Oils and Fats

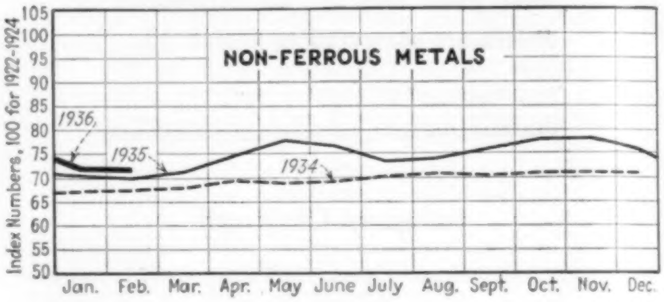
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb	$0.10 -$0.11	$0.10 -$0.11	$0.09½-$0.10
Chinawood oil, bbl., lb	.16½-......	.14½-......	.12-......
Coconut oil, Ceylon, tanks, N. Y. lb	.04¾-......	.05 -......	.06¾-......
Corn oil crude, tanks, (f.o.b mill), lb	.08¾-......	.09¾	.11 -......
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.08½-......	.08¾-......	.10½-......
Linseed oil, raw car lots, bbl., lb	.098-......	.098-......	.095-......
Palm, casks, lb	.04½-......	.04½-......	.05¾-......
Palm kernel, bbl., lb	.05¼-......	.05¼-......	nom.......
Peanut oil, crude, tanks (mill), lb	.08½-......	.08½-......	.10¼-......
Rapeseed oil, refined, bbl., gal	.52 -......	.55 -......	.50 -......
Soya bean, tank, lb	.08 -......	.08½-......	.10 -......
Sulphur (olive foots), bbl., lb	.08¼-......	.08½-......	.08⅛-......
Cod, Newfoundland, bbl., gal	.40 -......	.40 -......	.36 -......
Menhaden, light pressed, bbl., lb	.069-......	.072-......	.065-......
Crude, tanks(f.o.b. factory), gal	.36 -......	.36 -......	.30 -......
Grease, yellow, loose, lb	.04½-......	.05 -......	.06½-......
Oleo stearine, lb	.08¼-......	.08¼-......	.12 -......
Red oil, distilled, d.p. bbl., lb	.09¼-......	.09¼-......	.08⅛-......
Tallow, extra, loose, lb	.05¾-......	.06¼-......	.07 -......

CHEM. & MET.'S WEIGHTED PRICE INDEXES









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.14½- .15
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.10 - 1.25
Benzidine base, bbl, lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs., lb.	.48 - .52	.48 - .52	.48 - .52
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Benzol, 90%, tanks, works, gal.	.18 - .20	.18 - .20	.15 - .16
Beta-naphthol, tech., drums, lb.	.24 - .27	.24 - .27	.22 - .24
Cresol, U.S.P., dr., lb.	.11 - .11½	.11 - .11½	.11 - .11½
Cresylic acid, 99%, dr., wks., gal.	.58 - .60	.51 - .53	.50 - .51
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.29 - .30
Dinitrotoluen, bbl., lb.	.16 - .17	.16 - .17	.16 - .17
Dip oil, 25%, dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.38 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.65 - .70
Naphthalene, flake, bbl., lb.	.07 - .07½	.07 - .07½	.05½- .06
Nitrobenzene, dr., lb.	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.51 - .55
Phenol, U.S.P., drums, lb.	.14¼- .15	.14¼- .15	.14¼- .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., gal.	1.10 - 1.15	1.10 - 1.15	1.10 - 1.15
Resorcinal, tech., kegs, lb.	.65 - .70	.65 - .70	.65 - .70
Salicylic acid, tech., bbl., lb.	.40 - .42	.40 - .42	.40 - .42
Solvent naphtha, w.w., tanks, gal.	.26 -......	.26 -......	.26 -......
Tolidine, bbl., lb.	.88 - .90	.88 - .90	.88 - .90
Toluene, tanks, works, gal.	.30 -......	.30 -......	.30 -......
Xylene, com., tanks, gal.	.30 -......	.30 -......	.26 -......

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grid., white, bbl., ton	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb.	.14½- .15	.15 - .16	.12 - .13
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 - .20	.04 - .20	.04 - .20
Prussian blue, bbl., lb.	.37 - .38	.37 - .38	.35½- .37
Ultramarine blue, bbl., lb.	.10 - .26	.10 - .26	.06 - .32
Chrome green, bbl., lb.	.26 - .27	.26 - .27	.26 - .27
Carmine red, tins, lb.	4.00 - 4.40	4.00 - 4.40	4.00 - 4.40
Para toner, lb.	.80 - .85	.80 - .85	.80 - .85
Vermilion, English, bbl., lb.	1.59 - 1.60	1.59 - 1.60	1.56 - 1.60
Chrome yellow, C. P., bbl., lb.	.12 - .14	.12 - .14	.15 - .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.07 - .08½
Gum copal Congo, bags, lb.	.09 - .10	.09 - .10	.09 - .10
Manila, bags, lb.	.09 - .10	.09 - .10	.16 - .17
Damar, Batavia, cases, lb.	.15½- .16	.15½- .16	.16 - .16½
Kauri No. 1 cases, lb.	.20 - .25	.20 - .25	.20 - .25
Kieselguhr (f.o.b. N. Y.), ton	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -......	50.00 -......	40.00 -......
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	5.75 -......	5.65 -......	5.95 -......
Turpentine, gal.	.45¾-......	.49¾-......	.55½-......
Shellac, orange, fine, bags, lb.	.26 -......	.27 -......	.27 -......
Bleached, bonedry, bags, lb.	.24½-......	.24½-	.21 -......
T. N. bags, lb.	.14 -......	.14 -	.14 -......
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b. Ga.), ton	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton	13.75 -......	13.75 -......	13.75 -......

INDUSTRIAL NOTES

THE LINCOLN ELECTRIC Co., Cleveland, has moved its Pittsburgh office to 926 Manchester Blvd. F. M. Maichle is district manager.

THE TRANE Co., La Crosse, Wis., has placed Norbert D. Downey, formerly advertising manager, in charge of sales and merchandising.

FRANKLIN RESEARCH Co., Philadelphia, has purchased from Innis Speiden & Co., the business of the Wilbur White Chemical Co., Owego, N. Y.

E. F. HOUGHTON & CO., Philadelphia, has appointed L. D. Holland manager of research development with headquarters in the main office. Mr. Holland had been in San Francisco as sales manager of the Western Division where he has been succeeded by A. A. Miller.

THE FALK CORP., Milwaukee, has appointed M. A. Carpenter sales manager to succeed L. A. Graham, resigned.

NEWARK WIRE CLOTH Co., Newark, N. J., has named Robert H. Brinton, 1640 Castle Court, Houston, as its representative in Texas.

OWEN-DYNETO CORP., subsidiary of Electric Auto-Lite, has transferred its engineering staff, machinery, and equipment from Niagara Falls to Syracuse where it will manufacture and sell all USL arc welding equipment.

LINK-BELT Co., Chicago, has appointed Feenaughty Machinery Co., Portland, Ore., as its distributor in the Pacific Northwest.

CLARK TRUTRACTOR Co., Battle Creek, Mich., has added Harry B. Clapp to its staff in the capacity of transportation engineer.

MONSANTO CHEMICAL Co., St. Louis, is liquidating some of its wholly owned subsidiaries including the Rubber Service Laboratories Co., Akron, Virginia Fertilizer Co., Norfolk, and Wilckes, Martin, Wilckes, Camden, N. J.

PAPER MAKERS CHEMICAL CORP., Kalamazoo, Mich., has purchased the Providence Drysalters Co., Providence, R. I. and will operate it as a division of the corporation.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1936	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$140,000	....	$349,000	$137,000
Middle Atlantic	317,000	$137,000	1,071,000	272,000
South	237,000	1,374,000	417,000	1,889,000
Middle West	880,000	665,000	2,182,000	1,497,000
West of Mississippi	338,000	1,911,000	5,478,000	500,000
Far West	....	270,000	68,000	3,187,000
Canada	....	142,000	9,268,000	224,000
Total	$1,912,000	$4,499,000	$18,833,000	$7,706,000

PROPOSED WORK

BIDS ASKED

Chemical Factory—Dewey & Almy Chemical Co., 235 Harvey St., Cambridge, Mass., will soon award the contract for the construction of a 2 story, 57x142 ft. factory and office building. Estimated cost exceeds $140,000.

Factory—The Rubberoid Co., 500 Fifth Ave., New York, N. Y., manufacturer of asphalt and allied products, is receiving bids on general and separate contracts for an extension to its plant at Mobile, Ala. Estimated cost $200,000.

Factory—Vick Chemical Co., Greensboro, N. C., plans to alter and recondition its plant and laboratory on Wendover Ave., for the manufacture of medicated cough drops. Estimated cost $37,000.

Fertilizer Factory — Rauh & Sons, Union Stockyards, Indianapolis, Ind., contemplates the construction of a fertilizer factory. Estimated cost will exceed $40,000.

Gas Plant—City c/o H. A. Coffield, Mayor, Marfa, Tex., is receiving bids until Mar. 28, for the construction of a Butane air gas plant. A. V. Benner, El Paso, engr. Estimated cost $63,000.

Ink Factory—International Printing Ink Co., 75 Varick St., New York, N. Y., plans to repair its factory at 106 Dock St., St. Louis, Mo., recently damaged by fire. Estimated cost will exceed $40,000.

Paper Factory—Maryland Paper Products Co., 1200 South Eutaw St., Baltimore, Md., has taken over the factory at West, Cross and Eutaw Sts., and plans to alter same for its own use. Estimated cost $40,000.

Paper Factory — Merchants Paper Co., 819 Broadway, Cincinnati, O., J. Brenna, Pres., plans to repair its factory recently damaged by fire. Estimated cost $40,000.

Paper Plant—Odman Paper Co., 123 West Austin St., Chicago, Ill., plans to rebuild its plant recently destroyed by fire. Estimated cost will exceed $50,000.

Rayon Factory—Industrial Rayon Corp., West 98th St. and Walford Ave., Cleveland, O., is having plans prepared by Christian, Schwarzenberg & Gaede Co., archts., 1836 Euclid Ave., Cleveland, for additions to its factory, including new boiler house. Estimated cost $750,000.

Refinery—Parade Gasoline Co., Shreveport, La., plans to improve its refinery at Henderson, Tex. Estimated cost $275,000.

Refinery — Shoreline Refining Co. Shreveport, La., plans to construct a cracking unit at its refinery at Lewis, La. Estimated cost $200 000.

Warehouse—Maryland Distilling Co., Relay, Md., will soon award the contract for the construction of a 6 story, 131x134 ft. warehouse.

Machinery—Smith Paper Co., Inc., 22 Eagles St., Lee, Mass., R. A. Packard, supt. in charge, plans to purchase machinery for the manufacture of tissue paper for machine and finishing room.

CONTRACTS AWARDED

Alcohol Factory—Chemical Foundation, Inc., c/o L. M. Christianson, Ames, Ia., plans to construct an alcohol factory at Atchison, Kan. Separate contracts are now being awarded. Estimated cost $100,000.

Chemistry Building—Georgia School of Technology, M. L. Brittain, pres., Atlanta, Ga., will construct a 3 story Chemistry Building. Work will be done by day labor.

Chemistry Building—University of Alabama, Tuscaloosa, Ala., has awarded the contract for the construction of a 3 story Chemistry Building to Upchurch Construction Co., Montgomery, Ala. Estimated cost $101,490.

Chemical Factory—Chemical & Pigment Co., 6401 St., Helena Ave., Baltimore, Md., has awarded the contract for an addition to its plant to Price Construction Co., Maryland Trust Bldg., Baltimore. Estimated cost $45,000.

Chemical Factory—Maltbie Chemical Co., 250 High St., Newark, N. J., has awarded the contract for an addition to its factory to Carlson Co., 89 Walnut St., Montclair, N. J. Estimated cost $55,000.

Chemical Plant — Merrimac Chemical Co., Chemical Lane, Everett, Mass., has awarded the contract for the construction of a serric sulphate building to W. M. Bailey Co., 88 Broad St., Boston, Mass. Estimated cost $37,000.

China Factory—Hall China Co., East Liverpool, O., has awarded the contract for an addition to its factory to Potters Lumber Co., East Liverpool.

Dye Factory—Hanes Dye Co., Winston-Salem, N. C., awarded contract for an addition to its factory at Raleigh, N. C., to Frank L. Blum & Co., Winston-Salem. Estimated cost including equipment $37,000.

Factory—Hygrade Sylvania Corp., 60 Boston St., Salem, Mass., manufacturer of radio tubes, has awarded the contract for the construction of a factory on Loring Ave. to Leslie R. Porter Co., 156 Stuart St., Boston. Estimated cost will probably exceed $100,000.

Factory—U. S. Gypsum Co., 300 West Adams St., Chicago, Ill., awarded contract for addition to factory at Greenville, Miss., to H. K. Ferguson Co., Hannah Bldg., Cleveland O. Estimated cost $150,000.

Factory—Vanadium Corp. of America, Saunders Settlement Rd., Niagara Falls, N. Y., has awarded the contract for an addition to its factory to W. S. Johnson Bldg. Co., 2532 Hyde Park Blvd., Niagara Falls.

Factory—Viscose Co., Marcus Hook, Pa., R. H. Crewdson, engineer in charge, has awarded the contract for the construction of a factory in Vernon Township, near Meadville, Crawford Co., to Wark & Co., Sun Bldg., Philadelphia. Estimated cost $1,000,000.

Gas Plant—City, Cedar Falls, Ia., has awarded the contract for the construction of a water gas plant to Semet-Solvay Engineering Corp., 40 Rector St., New York, N. Y. New equipment purchased will include gas holder, two Semet-Solvay water gas machines, blowers, a condenser, tar extractor, exhausters, purifiers, tar storage, meter and scales. Water gas machines will be equipped for backrun operation. Estimated cost $35,000.

Glass Factory—Owens-Illinois Glass Co., 965 Weil St., Toledo, O. plans to construct an addition to its factory at East 12th St. and Macedonia Ave., Muncie, Ind., for the manufacture of glass brick, a new product. Maturity indefinite. Estimated cost $37,000.

Laboratory—University of Minnesota, Hennpin Island, Minneapolis, Minn., plans to construct a hydraulic laboratory. Work will be done under the direction of Lorenz Straub, Engineering College. Estimated cost $95,000.

Oil Extraction Plant—Continental Oil Co., Continental Oil Bldg., Denver, Colo., has awarded the contract for the construction of four oil extraction buildings to Stearns-Roger Mfg. Co., 1720 California St., Denver.

Phenol Recovery Plant—Carnegie-Illinois Steel Co., Carnegie Bldg., Pittsburgh, Pa., has awarded the contract for the construction of a hot vapor phenol recovery plant at the Clairton By-Products Coke Works, Clairton, Pa., to Koppers Construction Co., Koppers Bldg., Pittsburgh.

Refinery—Old Dutch Refining Co., Muskegon, Mich., J. Borden pres., has awarded the contract for installing a conversion unit at its crude oil refinery, to T. V. P. Corporation, 90 West St., New York, N. Y. Estimated cost $200,000.

Gasoline Absorption Plant—Pelican Oil & Gasoline Co., Shreveport, La., has awarded the contract for the construction of a gasoline absorption plant at Rodessa, La., to Frick-Reid Co., Tulsa, Okla. Estimated cost $200,000.

Refinery—Producers' Refining Co., Inc., West Branch, Mich., C. J. Westlund, Pres. and Mgr., will construct a 1,500 bbl. crude oil refinery in Ogemaw oil field, West Branch. Separate contracts have been awarded for the work. Estimated cost $75,000.

Oil Refinery—Pure Oil Co., Otter Creek Rd., Toledo, O., awarded contract for oil refinery addition to include combination topping, cracking and reforming plant to Lummus Co., 50 Church St., New York, N. Y. Estimated cost $750,000.

Paint Factory—Glidden Co. of California, 1300 7th St., San Francisco, Calif., E. L. Ralston, Supt. of Construction, California Hotel, San Francisco, will construct an addition to its factory at Daggett and 7th Sts. Work will be done by day labor. Estimated cost $70,000.

Paint Factory—Pacific Paint & Varnish Co., 4th and Cedar Sts., Berkeley, Calif., has awarded the contract for the construction of a paint factory to H. J. Christensen, 1953 Webster Ave., Oakland. Estimated cost excluding equipment $22,000.

Paint Factory—Sherwin Williams Co., 101 Prospect Ave., N. W. Cleveland, O., has awarded the contract for an addition to its factory at 548 East Kensington Ave., Chicago, Ill., to Lundoff-Bicknell Co., 100 North La Salle St., Chicago. Estimated cost $500,000.

Paper Factory—Chillicothe Paper Co., Chillicothe, O., awarded contract for three factory and office buildings to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $75,000.

Paper Mill—Grays Harbor Pulp & Paper Co., 23rd St. and Railroad Ave., Hoquiam, Wash., has awarded the contract for the construction of a mill to break up logs to Grays Harbor Construction Co., 609 H St., Hoquiam. Estimated cost $50,000.

Sulphuric Acid Plant—American Cyanamid & Chemical Co., 30 Rockefeller Plaza, New York, N. Y., has awarded the contract for the construction of a sulphuric acid plant at Joliet, Ill., to Chemical Construction Corp., 30 Rockefeller Plaza. Estimated cost $250,000.

Warehouse — Baltimore Pure Rye Distilling Co., Dundalk, Md., awarded contract for rack warehouse to Cogswell Construction Co., 406 Park Ave., Baltimore, Md. Estimated cost $100,000.

Warehouse—Owings Mills Distillery, Owings Mills, Md., awarded contract for warehouse to G. W. Tovell, Eutaw and McCulloch Sts., Baltimore. Estimated cost $100,000.

Warehouse—Turpentine & Rosin, Inc., Valdosta, Ga., will construct a 1 story, 140x150 ft. warehouse by day labor and sub-contracts.

Warehouse—Hiram Walker & Sons, Inc., Peoria Ill., has awarded the contract for the construction of two rack warehouses for its distillery to Val Jobst & Sons Peoria. Estimated cost will exceed $200,000.

CHANGES IN RATES OF DUTY FOR CHEMICALS, OILS AND PAINTS SINCE 1930

SINCE the Tariff Act of 1930 went into effect there have been many changes in the rates of duty for chemicals, oils, and paints. Warren N. Watson, secretary of the Manufacturing Chemists' Association, has made the accompanying compilation which shows the changes made in Schedule I since it was approved on June 17, 1930. These changes were made under Section 350, generally known as the "Reciprocal Trade Agreement Act," approved June 4, 1934, and under Section 336 of the Tariff Act of 1930, known as the "Flexible Tariff Provision" authorizing changes in rates based on differences in cost of production and other factors.

Under Section 350 many changes have been made in classification and there has been a downward revision of the tariff rates on a large number of products in Schedule I, thus making the original Tariff Act of 1930 of limited application to chemical imports.

This compilation includes all changes made up to and including the trade agreement with Switzerland announced on January 9, and effective February 15, 1936. The agreements proclaimed up to January 17 include the eight following countries: Cuba, Belgium, Haiti, Brazil, Sweden, Canada, The Netherlands, and Switzerland. (The agreements with Colombia and Honduras have not been proclaimed and ratified.)

The tabulation shows: (1) the paragraph of the Tariff Act of 1930; (2) the article; (3) the rate in the Tariff Act of 1930; (4) the new rate; (5) the effective date of the change; and (6) the number of the Treasury Decision.

Par. Tar. Act of 1930	Commodity	Old rate of duty	New rate of duty	Effective date of change
1	Acetic acid by weight more than 65% of acid	2¢ per lb.	1½¢ per lb.	1-1-36
1	Chloroacetic acid	5¢ per lb.	2½¢ per lb.	2-15-36
1	Barbituric acids N.S.P.F.	25% ad val.	25% ad val. (bound)	2-15-36
2	Vinyl acetate, polymerized or unpolymerized, and synthetic resins made in chief value therefrom, N.S.P.F.	6¢ per lb. & 30% ad val.	3¢ per lb. & 15% ad val.	1-1-36
4	Amyl alcohol, primary, secondary, or tertiary	6¢ per lb.	4¢ per lb.	2-1-36
4	Fusel oil	6¢ per lb.	4¢ per lb.	2-1-36
5	Laundry sour containing not less than 20% sodium silicofluoride and not less than 10% oxalic acid, N.S.P.F.	25% ad val.	15% ad val.	2-1-36
5	Ammonium silicofluoride	25% ad val.	15% ad val.	2-1-36
5	Salts and compounds of barbituric acids, mixtures of the foregoing, N.S.P.F.	25% ad val.	25% ad val. (bound)	2-15-36
5 and 23	Haarlem oil, whether or not in any form or container specified in paragraph 23	25% ad val.	15% ad val.	2-1-36
5 and 23	Salts and compounds of gluconic acid and combinations and mixtures; digitalis glucosides, and ergotamine tartrate	25% ad val.	15% ad val.	2-15-36
6	Aluminum sulphate[1]	⅜¢ per lb.	2/10¢ per lb.	5-1-35
10	Copaiba balsam, natural and uncompounded, and not containing alcohol	10% ad val.	5% ad val.	1-1-36
11	Synthetic resins made in chief value from vinyl acetate, N.S.P.F.	4¢ per lb. & 30% ad val.	3¢ per lb. & 15% ad val.	1-1-36
15	Caffeine	$1.25 per lb.	90¢ per lb.	2-1-36
15	Theobromine	75¢ per lb.	65¢ per lb.	2-1-36
20	Chalk or whiting or Paris white:			
	Dry, ground, or bolted	4/10¢ per lb.	2/10¢ per lb.	5-1-35
	Ground in oil (putty)	¾¢ per lb.	5/10¢ per lb.	
24	Flavoring extracts, and natural or synthetic fruit flavors, fruit esters, oils and essences, containing more than 50% of alcohol	80¢ per lb. & 25% ad val.	60¢ per lb. & 18% ad val.	2-1-36
24	Flavoring extracts, and natural or synthetic fruit flavors, fruit esters, oils and essences containing more than 20% and not more than 50% of alcohol	40¢ per lb. & 25% ad val.	30¢ per lb. & 18% ad val.	5-1-35
27	Naphthalene with solidifying point of 79 degrees C.	40% ad val. & 7¢ per lb.	20% ad val. & 3½¢ per lb.	5-1-35
28(a)	Coal-tar products: Colors, dyes, or stains, whether soluble or not in water, except those provided for in subparagraph (b) of paragraph 28	7¢ per lb. & 45% ad val.[2]	40% ad val., but not less than 3½¢ per lb. & 22½% ad val.[2]	2-15-36
28(a)	Artificial musk, not mixed and not compounded, and not containing alcohol, when manufactured from any of the products provided for in paragraph 27 or 1651	7¢ per lb. & 45% ad val.[2]	22½% ad val., & 7¢ per lb.[2]	2-15-36
28(a)	Heliotropin, not mixed and not compounded, and not containing alcohol, when manufactured from any of the products provided for in paragraph 27 or 1651	7¢ per lb. & 45% ad val.[2]	22½% ad val., & 3½¢ per lb.[2]	2-15-36
29	Cobalt:			
	Oxide	20¢ per lb.	10¢ per lb.	1-1-36
	Sulphate	10¢ per lb.	5¢ per lb.	5-1-35
32	Compounds of cellulose, known as vulcanized or hard fiber, made wholly or in chief value of cellulose	30% ad val.	20% ad val.	8-5-35
35	Ipecac, natural and uncompounded.	10% ad val.	5% ad val.	1-1-36
35	Mate, natural and uncompounded, but advanced in value or condition by shredding, grinding, chipping, crushing, not containing alcohol	10% ad val.	5% ad val.	1-1-36
37	Amyl acetate	7¢ per lb.	4¢ per lb.	2-1-36
41	Edible gelatin valued at less than 40¢ per lb.	5¢ per lb. & 12% ad val.	2½¢ per lb. & 12% ad val.	2-1-36
41	Gelatin, edible, valued at less than 40¢ per lb.	20% ad val. & 5¢ per lb.	12% ad val. & 5¢ per lb.	4-15-31
41	Gelatin and glue of animal origin, N.S.P.F., valued at less than 40¢ per lb.	25% ad val. & 2¢ per lb.	20% ad val. & 2½¢ per lb.	9-18-32
42	Glycerin, crude	1¢ per lb.	4/10¢ per lb. (Cuban)	9-3-34
42	Glycerin, refined	2¢ per lb.	½¢ per lb., plus the lowest rate of ordinary customs duty provided for crude glycerin the product of any foreign country except Cuba, at the time such refined glycerin is entered, or withdrawn from warehouse, for consumption; but not more than 1½¢ per lb.	2-1-36
52	Sperm oil, crude	10¢ per gal.[3]	2½¢ per gal.	1-1-36
52	Spermaceti wax	6¢ per lb.	3½¢ per lb.	4-1-33
53	Olive oil:			
	Weighing with container less than 40 lb.	9½¢ per lb. on contents and container	8¢ per lb. on contents and container	7-24-31
58	Distilled or essential cajeput oil not containing alcohol	25% ad val.	12½% ad val.	2-1-36
58	Distilled or essential grapefruit oil	25% ad val.	10% ad val. (Cuban)	9-3-34
60	Perfume materials not mixed, and not compounded, N.S.P.F. and not containing over 10% alcohol:			2-15-36
	Geraniol	45% ad val.	30% ad val.	
	Hydroxycitronellal	45% ad val.	22½% ad val.	
71	Acetylene black, dry or ground in or mixed with oil or water	20% ad val.	15% ad val.	1-1-36
72	Lead pigments:			
	White lead	2½¢ per lb.	2-1/10¢ per lb.	5-1-35
72	Lead pigments: Pigments composed in chief value of suboxide of lead, dry, or in pulp, or ground in or mixed with oil or water, N.S.P.F.	30% ad val.	3¢ per lb., but not less than 15% nor more than 30% ad val.	2-15-36
77	Lithopone, and other combinations or mixtures of zinc sulphide and barium sulphate containing by weight less than 30% of zinc sulphide	1¾¢ per lb.	1½¢ per lb.	2-1-36
81	Sodium phosphate (except pyro phosphate):			
	Containing by weight less than 45% water	1½¢ per lb.	1¢ per lb.	5-1-35
	Not specially provided for	½¢ per lb.	¼¢ per lb.	
83	Potato starch	2½¢ per lb.	1¼¢ per lb.	2-1-36
84	Dextrine, from potato starch or flour	3¢ per lb.	2¼¢ per lb.	2-1-36

[1] All aluminum sulphate, of whatever composition, from countries whose products are entitled to trade-agreement rates is now dutiable at 2/10¢ per lb.

[2] Based on American selling price if competitive and on United States value if noncompetitive.

[3] Rate reduced under Sec. 336 to 5¢ per gal., effective 4-1-33.